D.P.U. 91-233-D

Investigation by the Department of Public Utilities of Boston Edison Company's Second Annual Demand-Side Management Reconciliation Report and individual program reports and the Company's Conservation Charge.

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I. INTRODUCTION

A. Procedural History

On December 22, 1992, the Department of Public Utilities ("Department") approved a demand-side management ("DSM") settlement agreement ("1992 Settlement") between Boston Edison Company ("BECo" or "Company"), the Attorney General of the Commonwealth ("Attorney General"), the Commonwealth of Massachusetts Division of Energy Resources ("DOER"), the Conservation Law Foundation ("CLF"), the Energy Consortium ("EC"), and the Massachusetts Public Interest Research Group ("MASSPIRG") (collectively, the "Parties").[1] On June 18, 1993, pursuant to the 1992 Settlement, the Company filed with the Department its Second Annual Reconciliation Report ("Reconciliation Report") requesting incentive and lost base revenues consistent with the methodologies established in the 1992 Settlement (Exh. DPU-50; 1992 Settlement at 10). The Company filed supporting monitoring and evaluation reports ("M&E reports")[2] with the Department on June 15, 1993.[3] On August 23, 24, 30, and 31, and September

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[1] On November 4, 1991, the Company filed a petition for preapproval of DSM programs for 1992, including recovery of direct program costs, lost base revenues, and an incentive payment. This petition was docketed as D.P.U. 91-233. The 1992 Settlement determined program designs and budgets and established methods by which the Company's incentive and lost base revenues would be calculated. (See 1992 Settlement).

[2] The M&E reports consist of impact evaluations, process evaluations, and implementation evaluations which support the Company's Reconciliation Report. Impact evaluations use quantitative analyses to assess energy and demand savings resulting from the implementation of DSM programs. Process evaluations focus on qualitative issues such as program design and operational efficiency. Massachusetts Electric Company, D.P.U. 90-261, at 99 (1991). Implementation evaluations use installation and savings estimate information to determine an optimal level of program implementation (Exh. DPU-36, at 22).

[3] On June 18, 1993, the Company also filed a request for a Protective Order to protect (continued...)

10, 1993, the Department held technical conferences to investigate the Reconciliation Report and M&E reports. On November 2, 1993, pursuant to the 1992 Settlement, the Company filed its estimate of the 1994 conservation charge ("CC") rates to become effective February 1, 1994 (1992 Settlement at 6). As part of its CC filing, the Company filed proposed revised savings and participation goals for its 1994 DSM implementation.[4] On the same date, the Company filed a third amendment to the 1992 Settlement.[5] On November 24, 1993, the Parties submitted to the Department a fourth amendment to the 1992 Settlement.[6]

On December 21, 1993, the Department conducted a procedural conference with the Company and representatives of the Attorney General, CLF, MASSPIRG and DOER ("Non-Utility Parties" or "NUPs") to determine the schedule by which the investigation would proceed. On December 23, 1993, the Hearing Officer issued a Ruling on the Procedural Schedule ("Ruling") which divided the proceeding into three distinct proceedings: a CC proceeding; a Goals proceeding; and an M&E proceeding (Ruling at 3). On December 30, 1993, the NUPs filed

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from public disclosure the Reconciliation Report and the M&E reports. The Company's request was granted in part and denied in part in a Hearing Officer ruling dated December 23, 1993.

4 Savings goals are the kilowatthour and kilowatt savings projected to be achieved through the Company's DSM programs. Goals are established to govern the implementation of the Company's DSM programs, to estimate and recover lost base revenues, and as a base for the financial incentive calculation (See, 1992 Settlement at 12-13).

5 The first and second amendments to the 1992 Settlement were submitted on December 15, 1992, and January 27, 1993, respectively, and were approved by the Department on December 22, 1992, and on February 4, 1993, respectively.

6 The Department approved the third and fourth amendments to the 1992 Settlement on December 23, 1993.

an Appeal of the Hearing Officer's Ruling ("NUP Appeal"). The Company filed a response to the appeal on January 6, 1994. On January 21, 1994, the Department issued an order denying the NUP Appeal. Boston Edison Company, D.P.U. 91-233-1.[7]

On January 10, 1994, the Department conducted a hearing at its offices in the first of the three proceedings, the CC proceeding. The Department issued its Order regarding the CC proceeding on February 4, 1994. Boston Edison Company, D.P.U. 91-233-A (1994).
On January 25, 1994, the Department conducted a hearing at its offices in the second of the three proceedings, the Goals proceeding. The Department issued its Order regarding the Goals proceeding on March 22, 1994. Boston Edison Company, D.P.U. 91-233-C (1994).[8]

Pursuant to the procedural schedule, CLF and MASSPIRG filed testimony and a brief on monitoring and evaluation on February 18, 1994. On February 23, 1994, DOER notified the Department that it adopted the testimony and brief filed by CLF and MASSPIRG. The Company filed an initial brief in the M&E proceeding on March 3, 1994. On March 16, 1994, MASSPIRG and CLF filed a reply brief. On March 29, 1994, the Attorney General indicated that he joined in and adopted the initial brief filed by CLF and MASSPIRG, and that DOER and the Attorney General joined in and adopted the reply brief, as well.

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[7] In D.P.U. 91-233-1, at 8, the Department found that a minor modification to the schedule was appropriate. The Department found that the Company was not entitled to reconcile all differences to the CC on February 1, 1995, as implied by the Ruling. Id. Rather, the Department would require the Company to reconcile its CCs during the next fuel charge proceeding after the issuance of an order in the M&E proceeding, if appropriate.

[8] On July 23, 1993, the Attorney General filed a letter with the Department requesting approval of the scope of DSM research projects. On September 21, 1993, the Department issued a letter approving the scope of the DSM research projects. Boston Edison Company, D.P.U. 91-233-B (1993).

The evidentiary record contains 294 exhibits, including Company responses to 194 information requests and 26 record requests.

B. Overview of the M&E Proceeding

The Company's Reconciliation Report provides final estimates of program energy and capacity savings resulting from installations made during the 1991 program year (Exh. DPU-50, at 1). The Reconciliation Report also provides the initial or first true-up of savings estimates from the 1992 installation period (id. at 2). The results of the M&E impact evaluations are used by the Company and the Department for future resource planning purposes and for determining net program savings to support recovery of both lost base revenues ("LBR") associated with DSM program delivery and financial incentives earned by the Company in 1991 and 1992. Table 1 summarizes the results of the impact evaluations contained in the M&E reports.[9]

In this Order, the Department addresses whether the Company's 1992 impact evaluations satisfy the criteria established by the Department for the review of such evaluations.[10] The Department also will review the annualized and lifetime savings estimates for measures installed.[11]

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[9] The Company claimed a dramatic change in its avoided costs, and a similar, consequent change in the benefit/cost ratio of its DSM programs, from 1991 to 1992.

[10] The Department does not address in this Order the process and implementation evaluations included in the M&E reports. The Department notes that companies are expected to consider all recommendations contained in the process and implementation evaluations and to revise program designs to reflect all appropriate recommendations. However, the Department used information from the process evaluations to assess the quality of data used in the impact evaluations for some programs.

[11] The Department may approve lifetime savings estimates for purposes of this proceeding. However, because lifetime savings estimates will change as new persistence data become available, approved lifetime savings estimates are subject to review and modification in future M&E proceedings before the Department.

Because the LBR and incentive payments that the Company is entitled to recover, associated with the implementation of DSM programs during 1991 and 1992, are ultimately to be based on savings estimates that are approved by the Department, the Company may be required to recalculate the LBR and incentive components of the CC to reflect the directives in this Order. See, Boston Edison Company, D.P.U. 91-233-A (1994).

C. Description of DSM Savings Estimation Techniques

The energy and capacity savings estimates produced by the impact evaluations are used by the Company and the Department for planning purposes and for determining the DSM incentive and LBR allowed to the Company in a particular year. In order to serve these purposes, the impact evaluations must produce savings estimates that (1) reflect the period of time over which the energy conservation measures ("ECMs") can be expected to generate savings (i.e., "lifetime" savings estimates), (2) reflect the level of demand savings that occur at the time of, or coincident with, a company's peak power demand (i.e., "coincident" demand savings),[12] and (3) do not include the level of savings that would have occurred in the absence of implementation of the DSM programs (i.e., "net" savings estimates).[13] To determine net savings estimates, gross savings estimates must be adjusted to take into account non-program factors that may affect the electricity

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[12] Savings estimates that do not take into account the level of demand savings that occur at the time of a company's peak power demand are referred to as "non-coincident" demand savings estimates.

[13] Savings estimates that include the level of savings that would have occurred in the absence of implementation of the DSM programs are referred to as "gross" savings estimates.

consumption of program participants. These factors include free-ridership,[14] economic conditions (both general and firm-specific),[15] weather, spillover,[16] and snapback.[17] In recent Orders, the Department has specified various methods by which energy and capacity savings estimates should be determined, including engineering estimates, billing analysis and end-use metering methodologies. See Massachusetts Electric Company, D.P.U. 92-217-B at 7-16 (1994); Cambridge Electric Light Company and Commonwealth Electric Company, D.P.U. 94-2/3-CC at 9-18 (1994).

II. STANDARD OF REVIEW

The Department has established the criteria to be used in the review of electric companies' DSM impact evaluations through a series of previous orders. To ensure the reliability of the

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[14] A free rider is defined as a program participant who would have installed an ECM without direct payment from a utility company. D.P.U. 86-36-F at 25-26. A pure free rider would have spent the same amount of money to install the same energy-efficient measures at the same time without benefit of a utility company's program. A partial free rider would have spent less money, installed less equipment, installed only somewhat efficient equipment, and/or installed the equipment at a later date.

[15] Firm-specific economic conditions may include changes in floorspace, equipment, hours of operation, industrial process configuration, output, employment, and/or sales.

[16] Spillover is an effect of DSM programs whereby customers' purchases of energy-using technologies or behavioral patterns are altered but those customers do not ask for a rebate from the electric company and are not considered "participants" of the company's DSM programs. Free-drivers, customers whose installation of ECMs is attributable to a company's marketing of a DSM program but do not participate in a utility-sponsored DSM program or receive payments from a utility, are considered to be a subset of spillover. Western Massachusetts Electric Company, D.P.U. 89-260, at 11-12 (1990).

[17] Snapback is an effect where a customer responds to the lower cost of accomplishing a task after implementation of an ECM by increasing energy consumption. Consequently, some of the projected savings for a DSM program are lost as the result of increased use by participants after an ECM is installed.

savings estimates produced by the impact evaluations, the Department has directed companies to minimize bias in the savings estimates. Massachusetts Electric Company, D.P.U. 92-217-B at 4 (1994) ("D.P.U. 92-217-B"); Boston Edison Company, D.P.U. 90-335, at 105 (1992) ("D.P.U. 90-335"); Western Massachusetts Electric Company, D.P.U. 91-44, at 140, 143 (1991) ("D.P.U. 91-44"). The Department has found substantial bias in engineering estimates of DSM savings and, accordingly, generally has required companies to measure savings after the installation of ECMs.[18] D.P.U. 92-217-B at 4-5; D.P.U. 90-335, at 106; Nantucket Electric Company, D.P.U. 91-106/138, at 212-215 (1991); Massachusetts Electric Company, D.P.U. 90-261, at 79, 80, 85 (1991) ("D.P.U. 90-261"); D.P.U. 91-44, at 142-143.

The Department has identified some sources of bias in savings estimates, including: (1) poor selection of samples used in savings measurement analyses (D.P.U. 90-261, at 138); (2) inaccurate hours-of-use estimates (D.P.U. 90-335, at 105; D.P.U. 91-44, at 142); (3) the failure to account for free riders (D.P.U. 90-335, at 111-112); (4) the failure to account for interactions of multiple DSM measure installations (Cambridge Electric Light Company and Commonwealth Electric Company, D.P.U. 89-242/246/247, at 78-79 (1990)); and (5) overestimated persistence of savings (D.P.U. 90-335, at 110-111; D.P.U. 91-44, at 147-148).

The Department has recognized that, in certain instances, the costs of obtaining more precise estimates of savings may exceed the incremental value of those more precise estimates.

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[18] The Department has allowed savings estimates that are not based on after-the-fact measurement for programs in which (1) only one well-defined end use is involved and the hours of operation of the installed ECMs are very predictable or controlled by a company, or (2) a company can demonstrate that no after-the-fact measurement is possible. D.P.U. 90-261, at 109; D.P.U. 90-335, at 109, n.40; D.P.U. 91-44, at 142.

D.P.U. 90-261, at 100. Therefore, the Department has directed companies to pursue savings measurement activities that maximize the level of precision of the DSM savings estimates, but only to the extent that the marginal value of the more precise savings estimates exceeds the marginal cost of obtaining the additional precision. D.P.U. 90-335, at 100-103, 110; D.P.U. 90-261, at 106, 108.

The Department notes that this is the first comprehensive, post-installation review of this company's DSM impact evaluations. Therefore, for the purposes of this proceeding, the Department will accept savings estimates provided that they are sufficiently unbiased and sufficiently precise, considering the nature of the program, the company's resources, and the costs and value of obtaining better precision.

However, in future impact evaluation reviews, the Department will accept an electric company's savings estimates if the company can demonstrate that the impact evaluations are reviewable and appropriate, and the estimates are reliable. See D.P.U. 92-217-B at 6 (1994). A company's impact evaluation filing will be considered reviewable if the record is complete, clearly presented, and contains a summary that sufficiently explains all assumptions and data presented. Id. An impact evaluation will be considered appropriate if evaluation techniques selected are reasonable given consideration of the characteristics of a particular DSM program, the company's resources, and the available methods for determining demand and energy savings estimates.[19] Id. Finally, the savings estimates included in an impact evaluation will be considered reliable if the

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[19] The Department recognizes that the state-of-the-art in methods used to determine DSM savings estimates is evolving and expects companies to remain up to date with technological and methodological advances in this field.

estimates are sufficiently unbiased and are measured to a sufficient level of precision, considering the characteristics of a particular DSM program, the company's resources and the available methods for determining demand and energy savings estimates. Id. Interested parties will have the opportunity to comment on this standard of review in future proceedings.

III. THE COMPANY'S DSM IMPACT EVALUATIONS

A. Introduction

The Company submitted impact evaluations for most of the DSM programs that it implemented during 1991 and 1992 (Exh. BE-1, App. 1). Programs targeting the C/I sector include (listed in order by amount of claimed energy savings) ENCORE, Large C/I Retrofit, Small C/I Retrofit, Equipment Replacement, Remodeling, Design Plus, Cool Storage, and three load management programs: BEEC, GAP, and TOULC (id. at 19-A). Programs targeting the residential sector include Efficient Lighting, Energy Fitness, Multi-Family, High Use, Boston Housing Authority, Public Housing, HVAC Rebate, Heat Pump Tune-Up, Appliance Labelling, New Construction, and one load management program: A/C Cycling (id.). Table 1 provides a summary of 1991 and 1992 DSM activities. Table 2 provides the Company's claimed energy savings and realization rates, based on the second M&E true-up, for the 1991 DSM implementation, and whether or not the Department accepts such claims.[20] Table 3 provides

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[20] In their respective briefs, the NUPs and the Company dispute the way in which BECo labels its savings estimates as "net" savings (NUP Brief at 32-33; BECo Brief at 25). The Department notes that the Company's savings estimates in all filings before the Department should be consistent with the definitions established by the Department. As described in Section I.C, above, to determine net savings estimates, gross savings estimates must be adjusted to take into account non-program factors such as free-ridership, economic conditions (both general and firm-specific), weather, spillover,

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similar information for the first true-up of savings estimates for the Company's 1992 DSM implementation.

Below, the Department separately reviews the impact evaluations for many of the programs, especially those for which the Company has claimed large savings estimates or where savings estimates are contested by the intervenors. Where the Company has jointly evaluated multiple programs, the Department reviews those programs jointly. Finally, the Department briefly addresses the savings estimates for programs for which small amounts of savings are claimed that are not contested by the intervenors.

B. Quality of Data

The NUPs raise several issues regarding the quality of data used to develop the Company's savings estimates (NUP Brief at 4). The NUPs provide numerous general and program-specific criticisms of the Company's data collection and management procedures. They also argue that as a result of these shortcomings, the Department should not allow the Company to recover LBR or an incentive until it has improved the analyses of its 1991 programs (id. at 5).[21] In the alternative, the NUPs suggest that the Department adopt the alternative savings estimates they develop in their brief (id.).

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[20](...continued)
and snapback. In future filings, the Company should clearly indicate whether claimed savings estimates are initial or final and to what extent these non-program factors have been accounted for.

[21] The NUPs cite specific data quality problems such as data incompleteness, errors in the program databases, errors in engineering estimates of savings, and incompatibility of customer billing data with program records, specifically with the Large Commercial/Industrial Retrofit Program and the Multifamily Program evaluations (id. at 7-9).

In response to the NUPs' arguments, the Company states that while the integrity and consistency of both the data and the database have been a major concern, the absence of clearly defined data collection procedures and responsibilities led to confusion in 1990 and 1991 (Company Brief at 11-12). However, the Company also states that the data available are more than adequate to develop reliable evaluations (id. at 6). The Company attributes its failure to collect certain data during 1991 to the demands of program start-up and completion of customer installations (id.). The Company states that initially it gave higher priority to training new DSM staff and to program implementation in 1991, before turning its attention to data collection procedures (id.). The Company claims that it has shifted the focus of its efforts to improve data quality and collection procedures (id.).

The record indicates that the Company has made significant strides in improving the data available for program management and evaluation. As a result, the Department anticipates that most, if not all, of the weaknesses in data collection that hampered the evaluation of 1991 program implementation have been corrected and will not detract from the evaluation of program implementation in subsequent years. To the extent data quality problems exist within the evaluations of specific programs, the Department will consider them on a program-by-program basis, below.

C. Commercial and Industrial Programs

1. ENCORE Program

a. Description

From 1988 through 1992, the ENCORE program has served commercial and industrial customers with monthly billing demand of at least 150 kilowatts ("KW") (Exh. BE-1, at 336).

The ENCORE program provided technical assistance and ECM installations through energy service companies ("ESCos") (id.). The ESCo selected by a BECo customer is paid over the life of a three-party contract (among the customer, the ESCo, and BECo) based on verified savings and a contracted price per kilowatthour ("KWH") (id.).

BECo's impact evaluation used billing analysis to estimate savings from ENCORE over the five-year period from 1988 through 1992 (Exh. DPU-27, at 3.7). After aggregating data from multiple accounts at various facilities, BECo replaced anomalous bill readings with interpolated data or data from the same month in another year (id. at 2.2-2.3). Of the 144 program participants during this period, BECo found that 104 had enough bills to use in the impact evaluation (id. at App. C; Exh. DPU-2-3). BECo divided its sample of 104 participants into groups representing eleven building types (Exh. DPU-27, at 3.2). BECo also developed a comparison group of 176 customers, stratified by the same eleven building types (Exh. DPU-2-15).[22]

For each participant with enough usable data, BECo performed a regression analysis to estimate the effects of heating degree days, cooling degree days, and predicted savings on monthly electricity consumption (Exh. DPU-27, at 3.4). For 56 of the 104 participants, BECo rejected the results because they were "non-intuitive" and/or "insignificant," because the t-ratios were negative (indicating increased usage) or not positive enough (indicating little confidence that the indicated savings were real) (Exh. DPU-3-2). BECo claimed that results which did not show significant savings indicated substantial activities that were not program-related (id.).

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[22] BECo did not show that its comparison group was matched to its participant group according to other criteria as well, such as energy use or facility size (id.).

BECo next calculated an average realization rate for each of its eleven building types, based on a weighted average of the realization rates for participants which exhibited significant, "intuitive" results (Exh. BE-1, at 339). BECo then applied these building type-specific realization rates to facilities with non-intuitive and/or insignificant results (id.). Thus, BECo determined that the total weighted average gross realization rate for the program was 47.6 percent (Exh. DPU-27, at 3.6).

BECo used its comparison group, after eliminating 78 percent of the observations[23] because the results were not significant at the 95 percent confidence level, to estimate that energy use decreased by 0.2 percent in the absence of the DSM program (id. at 3.12; Exh. DPU-2-21).[24] Finally, BECo reduced its 47.6 percent gross realization rate by 0.2 percent to estimate the net realization rate for the program (Exh. BE-1, at 340). BECo stated that the precision of the resulting estimate is ±9.5 percent at the 90 percent confidence level (id. at 39).

BECo estimated capacity savings by multiplying its estimated energy savings by load factors filed by BECo (Exh. DPU-2-2). BECo also analyzed demand data from each participant's bills[25] to determine any statistically significant reduction in average monthly demand from before

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[23] Actually, BECo replaced the indicated values with zero (Exh. DPU-2-20).

[24] In response to a Department request, BECo calculated the change in energy use by the comparison group without eliminating insignificant observations (Exh. DPU-11-9).

[25] Some participants had interval demand meters, while others had maximum demand meters (Exh. DPU-2-5). Interval demand meters total and record electricity use during each interval, typically 15 minutes. Maximum demand meters, also known as ratchet meters, record a new KW reading whenever the current reading exceeds the previous maximum reading. Maximum demand meters are commonly reset to zero once a month, so that the maximum demand for the next month can be determined. Interval demand meters will thus provide almost 3,000 readings per month, while a maximum demand

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participation to afterward (Exh. DPU-27, at 3.10 and App. F). However, BECo was unable to reliably estimate capacity savings based on billing demand meters, because many of them were only maximum demand meters (rather than interval demand meters) and because many comparison group members did not have such meters, making it difficult to estimate coincidence and non-program effects reliably (Exh. DPU-11-11). Accordingly, BECo relied on the previously filed load factors to estimate capacity savings (id.).

b. Positions of the Parties

i. NUPs

The NUPs contend that BECo's decision to eliminate facilities with "non-intuitive" and "insignificant" results removed facilities with low true savings, thereby biasing the results and overestimating the true energy savings of the program (NUP Brief at 25). Indeed, the NUPs claim that "BECo has simply eliminated undesirable savings results where low or negative savings would have reduced the recovery of lost base revenues" (NUP Reply at 17). The NUPs contend that the gross realization rate would be 29 percent or 30.95 percent if facilities were not screened out (NUP Brief at 26, citing Exh. NUP-4, at Response to ENCORE Impact Question 4, and Exh. DPU-11-8).

Further, the NUPs contend that BECo's capacity savings estimate is biased upward, because it is based on the biased energy savings estimate (id. at 27). The NUPs also criticize the lack of documentation for BECo's load factor assumption (id.). The NUPs argue that, given the

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[25](...continued)
meter will typically provide one reading per month.

size and value of the capacity savings from this program, BECo should independently verify capacity savings by using on-site metering (id.).

The NUPs maintain that BECo's comparison group does not account adequately for free ridership (id. at 27-28). In particular, the NUPs contend that BECo should analyze the degree to which the sample of participants used to develop savings estimates is similar to the group of all participants and to the comparison group of facilities (id. at 28).

The NUPs ask the Department to direct BECo to (1) recalculate the savings estimates for the ENCORE program using a 29 percent gross realization rate in the interim; (2) assess the degree to which the comparison group represents program participants; and (3) recalculate and "true up" lost base revenues for the savings achieved by the program in 1991, based on the recalculated savings estimates (id.). The NUPs add that the Department should explore further the reasons for the low realization rate, which indicates significant upward bias in engineering estimates and verified savings developed by ESCos (id. at 29).

ii. BECo

BECo claims that it would be inappropriate to include illogical and insignificant results in developing savings estimates (Company Brief at 22). BECo contends that the crux of the NUPs' argument is that BECo excluded participants whose true savings were very low (id. at 21). BECo claims that if the true savings were known, no further analysis would be needed, and that the NUPs have not identified a single instance where a true saving that was low was excluded (id.). Regarding non-program effects, BECo argues that no one knows what any participant would have done absent the program, but BECo worked hard to identify a comparison group for ENCORE (id. at 22). BECo claims that the NUP critique of BECo's capacity savings estimate

indicates that the NUPs do not understand the concept of coincident peak and ignores the fact that the NUPs helped develop the load shape data from which BECo's load factors came (id.).

c. Analysis and Findings

The record shows that BECo's method of screening data excluded the majority of the facilities with usable data from its estimate of the program's overall realization rate, namely those facilities where BECo's analyses found the estimated realization rate to be negative or not significant. BECo claims that the excluded results reflect non-program-related increases in energy use by these participants and termed these results illogical or not significant. However, BECo did not exclude results that may have indicated a decrease in energy use due to non-program effects.[26]

Moreover, the record demonstrates that BECo used a comparison group for this program.[27] The Department notes that the purpose of a comparison group is to adjust for non-program effects. The record contains no evidence that BECo's comparison group did not adequately adjust for non-program effects.

The Department notes that non-program effects increase energy use for some participants and decrease energy use for other participants. Thus, non-program effects make some

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[26] The Department notes that an increase in energy use for a program participant may at first appear non-intuitive, but is a logical result of a decrease due to the DSM program combined with a larger increase due to non-program effects. Similarly, a "non-significant" decrease in energy use is likely to be the result of a decrease due to the program and a smaller increase due to non-program effects. Most of the data BECo retained is likely to be the result of a decrease in energy use due to the DSM program combined with a further decrease due to non-program effects.

[27] The Department recognizes that BECo's comparison group may not match its participant group as well as the NUPs might like, but also recognizes that an exact match is impossible and that BECo expended significant effort to construct a comparison group in a sector where constructing any reasonable comparison group is challenging.

participants' savings appear smaller than they in fact are, but make other participants' savings appear larger than they actually are. The Department finds that BECo excluded results which reflect non-program-related increases in energy use but failed to similarly exclude results which reflect non-program-related decreases in energy use. Accordingly, the Department finds that BECo's treatment of non-program effects biases BECo's savings estimate upward.

Therefore, the Department finds that BECo's ENCORE energy savings estimate is not sufficiently unbiased. Accordingly, the Department rejects BECo's estimate and directs BECo, in a compliance filing, to revise its energy savings estimate for ENCORE by including all sampled facilities with usable data for both the participant group and the comparison group, as calculated by BECo in Exhs. DPU-11-8 and DPU-11-9. The Department further directs BECo to recalculate its lost base revenues consistent with its recalculated savings.

The record shows that BECo estimated capacity savings by applying an assumed load factor, which was based on its own load research and which was not detailed in this filing, to its energy savings estimate. The record also contains BECo's estimate of gross, non-coincident demand savings based on billing demand meters at many participating facilities. The NUPs contend that BECo should use on-site metering, but the record shows that BECo has not done so, leaving such data unavailable. Regarding the available estimates, the Department finds that the benefits of BECo's net, coincident, but unmeasured capacity savings estimate outweigh the benefits of using a savings estimate based on gross, non-coincident, but measured data from participants. Accordingly, the Department directs BECo to apply its filed load factor to (1) the energy savings estimate revised in accordance with Exhs. DPU-11-8 and 11-9, and to (2) its lost base revenue calculation. However, billing demand meters and on-site metering may offer

promising bases for estimating demand savings. Therefore, in future analyses of programs where a large fraction of participants have billing demand meters, the Department directs the Company to explore the use of data from such meters, with adjustments for coincidence (based on interval demand meters) and for non-program effects (e.g., by using a comparison group), to estimate capacity savings and to report the results of its efforts to the Department with the next evaluation of the programs undertaken after this Order. Likewise, the Department directs BECo to explore the feasibility and cost-effectiveness of on-site demand metering for its large C/I programs and to report the results of its efforts to the Department with the next evaluation of these programs undertaken after this Order.

In D.P.U. 90-335, at 110-111, the Department directed the Company to conduct follow-up surveys at appropriate intervals to estimate persistence. The record indicates that BECo has not yet measured explicitly the persistence of savings from this program. Because billing analysis implicitly reflects the persistence of ECMs to date, the Department finds a persistence adjustment to BECo's savings estimates for this program to be unnecessary at this time. However, the Department reiterates its requirement that, in the future, BECo measure ECM persistence at appropriate intervals.

2. Large Commercial and Industrial Retrofit Program

a. Description

The Large C/I Retrofit Program provides technical assistance and financial incentives to many BECo customers with monthly peak demands of at least 150 KW (Exh. BE-1, at 256). The program offers efficiency improvements to lighting, motors, heating, ventilation and cooling ("HVAC"), industrial process, and energy management systems[28] (id.). BECo divided its 3,000

(continued...)

eligible customers into institutional and non-institutional ("business") customer groups, using different marketing strategies, verification requirements, and incentive payment structures for each group (id.).

BECo based its impact evaluation on billing analysis of a sample consisting of all 116 participants from 1991 with usable data (Exhs. DPU-1-3; DPU-1-6, Att. B at 1-3).[29] The impact study noted that survey data from participants contained no information on operational factors affecting electricity consumption by customers, such as employment levels or output (Exh. DPU-53, at 2.1). The impact study calculated realization rates for each participant, based on the average daily electricity consumption before and after ECM installation (Exh. BE-1, at 262; Exh. DPU-53, at 1.4).

BECo's data manifested problems which resulted in an extremely wide distribution of realization rates (Exh. DPU-53, at 1.4; DPU-1-6, Att. B at 1-3). Underlying these results were two problems: data errors and low "signal-to-noise" ratios.[30] Low signal-to-noise ratios (very high or negative realizations rates) appeared when anticipated savings were very small relative to consumption (Att. B at 1-3; Exh. NUP-3). Moreover, three of the largest participants each cut total electricity use by more than 45 percent, despite predicted savings of less than 2 percent (id.).

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[28](...continued)
Energy management systems use thermostats, occupancy sensors, and similar equipment to control the operation of lighting, heating, and cooling systems.

[29] Thirteen participants were excluded because data on energy consumption before measure installation were not available (Att. B at 1-3; Exh. NUP-3).

[30] As used here, the signal is the savings due to the ECMs installed through the DSM program. The noise is the change in electricity consumption due to other factors.

BECo stated that the distribution of its data created several severe statistical problems (Exh. DPU-53, at 1.4).

To deal with the statistical problems, BECo chose to use a median for both distributions, claiming that the median is a robust measure of the central tendency of a distribution in the presence of great dispersion (id. at 1.8). BECo calculated the respective median realization rates for its two groups of participants -- 123.85 percent for businesses and 36.37 percent for institutions -- and multiplied its original engineering estimates by these rates (id. at 1.8 and 6.2; Exh. BE-1, at 269-270).[31] The resulting gross overall realization rate estimated by BECo, combining businesses and institutions, was 86.24 percent (Exh. DPU-53, at 6.2). To estimate net savings, BECo reduced its gross savings estimate by 29 percent to account for free riders, for a 61 percent net realization rate (Exh. BE-1, at 270).[32] Finally, BECo calculated the capacity savings from this program using its estimated energy savings and its own end-use load shapes (id. at 264).

b. Positions of the Parties

i. NUPs

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[31] At the Department's request, BECo checked its median realization rates using a method called "alpha-trimming," which calculates means of the remaining observations after deleting equal numbers of the highest and lowest observations (Exhs. DPU-11-2; DPU-1-17, Att. F, at 71). The results converged to 39 percent for institutions, 104 percent for businesses, and 71 percent for all participants, substantially less than BECo's overall result (Exh. DPU-11-2).

[32] The adjustment was based on the "pure" free rider rate from the lighting portion of a customer survey, since lighting was the predominant end use installed by this program in 1991 and 1992 (id.). Most other respondents (for lighting and other technologies) indicated that they were partial free riders (Exh. DPU-33, at IV-22).

The NUPs identify two types of problems with the data BECo used to develop Large C/I Retrofit Program savings estimates (NUP Brief at 13-18). First, the NUPs identify erroneous and implausible data, showing that observed changes in electricity use exceeded total consumption (before ECM installation) for five or six facilities[33] and that predicted savings exceeded total use for 13 or 14 facilities (NUP Brief at 13-14, citing Exhs. NUP-3 and DPU-1-6, Att. B at 1-3). The NUPs add that 12 more facilities showed relative predicted impacts of 50 percent to 100 percent (id.). The NUPs argue that only a few participating businesses have "plausible" results (observed savings within ±50 percent of predicted savings), and that half the participating businesses have highly implausible results (more than ±2 times predicted savings) (NUP Reply Brief at 8-9, citing Exh. NUP-1). Second, the NUPs identify data with low signal-to-noise ratios (NUP Brief at 19-20).

The NUPs identify two types of reasons for the data problems: overpredicted savings and undermeasured consumption (id. at 13-14). In turn, the NUPs identify several sources of error which cause overpredictions: errors in estimation procedures and numerical assumptions, data entry errors, and failure to check predictions against current total use (id. at 14). The NUPs likewise identify several sources of error which cause undermeasured consumption: data entry errors, failure to include data from some billing meters (where a facility has multiple meters), and failure to match meters to the correct facilities (id.; NUP Reply Brief at 9).

The NUPs offer guidelines for data handling in impact evaluations: (1) investigate possible data errors, such as predicted or observed savings exceeding half of total use, correcting

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[33] Indeed, two of these six businesses showed savings alone of several times the combined consumption by all participants (Exh. NUP-3; Att. B at 1-3).

data as appropriate; (2) screen out data which are wrong but cannot be fixed; and (3) identify and investigate statistical and logical outliers, correcting appropriately for the influence of such observations (NUP Brief at 15). The NUPs add that efforts should focus on observations with large predicted impacts and large statistical influence (id.). The NUPs claim that there is no evidence that BECo investigated or corrected the causes of its data problems (NUP Reply Brief at 9). The NUPs contend that if the data contain errors, then the savings estimates based on that data are invalid (id.).

The NUPs contend that BECo failed to gather and use data required by the Department to adjust for non-DSM program effects on electricity consumption (NUP Brief at 16-18, citing BECo, at 98). The NUPs state that, to account for non-DSM effects on consumption changes (1) comparison groups should be used; (2) normalization or regression approaches should be used; or (3) non-DSM influences (free riders, weather, customer behavior, economic climate, and facility changes) should be analyzed separately (id. at 17). The NUPs add that spillover and snapback effects also might significantly affect consumption (id. at 16-17). Moreover, the NUPs criticize BECo's free-rider estimate as flawed because it was based on a few survey questions, used data for lighting measures only, and weighted responses by number of customers rather than by predicted savings (id. at 17). The NUPs recommend that the Department direct BECo to adjust for the factors listed above, where reasonable and appropriate, using non-participant data for similar facilities and free-rider estimates based on respondents' predicted savings (id. at 18). The NUPs also ask that BECo collect and use data on facility changes and weather-dependent load (id.).

The NUPs claim that BECo's analysis is sensitive to projects with savings that are small relative to year-to-year variations in consumption (id. at 19). The NUPs contend that facilities with small relative savings have low signal-to-noise ratios, making it difficult to discern program savings using billing analysis (id. at 19). To emphasize the difficulty of estimating savings due to this program, the NUPs estimated the realization rate of businesses served by the program (as opposed to institutions) at anywhere from 16 percent to 18,000 percent, using four estimation methods with four different screens of BECo's data (id. at 20, citing Exh. NUP-1, at Table 1-3). The NUPs claim that even statistically robust estimators (which should yield very similar estimates) yield realization rates ranging from 63 percent to 133 percent, using BECo's data (id. at 20).

The NUPs argue that actual realization rates may vary systematically by facility type and size, and that estimated realization rates should reflect any such systematic differences (id.). The NUPs offer four methodological guidelines for estimating program savings for a program with a small population and wide variation in savings: (1) segment both the population and the sample, according to systematic differences among types of customers; (2) concentrate special efforts on large savers; (3) use different methods (billing analysis, end-use metering, site-specific engineering analysis, etc.) for different segments as appropriate; and (4) use methods that weight facilities by expected savings (id. at 21-22).

The NUPs performed an independent calculation of the savings due to this program (Exh. NUP-2). Using the guidelines above, the NUPs offer an estimated realization rate for the Large C/I Retrofit Program, based on a technique which they term "robust" regression analysis (NUP Brief at 22, citing Exh. NUP-2). The NUPs state that robust regression weights facilities

based on their contribution to total program savings, while limiting the undue influence of outliers (i.e., data observations with large error terms, or residuals[34]) and leverage points (i.e., data observations identified as having a particularly strong influence on the results of the analysis) (id. at 22). Like BECo, the NUPs analyzed businesses and institutions separately,[35] applied the separate realization rates from the samples to the two populations of participants, and added the results to determine gross program savings (id., citing Exh. NUP-2, at 2-3). To create a suitable sample, the NUPs screened out facilities to reduce the impact of missing data, data errors, and large apparent changes in consumption that were unlikely to be due to the program (id.). Using robust regression analysis, the NUPs calculated realization rates of 63.3 percent for one very large business, 98.0 percent for other businesses, and 38.7 percent for institutions (id. at 22-23, citing Exh. NUP-2, at 3). Finally, the NUPs scaled up from the samples to the population and added the results to obtain a 64.2 percent gross realization rate for the program (id., citing Exh. NUP-2, at Table 2-7).

The NUPs contend that their estimate accounts for changes in consumption due to non-program effects, such as economic conditions, but does not account for free riders, since the analysis applies only to participant data (NUP Reply Brief at 15-16).

The NUPs claim that their energy savings estimate is limited by the poor quality of BECo's data, and thus still may not be a sufficiently reliable estimate of program impacts (NUP Brief at 24). Accordingly, the NUPs ask the Department to require BECo to (1) re-estimate program

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[34] A residual refers to the difference between the actual value of the dependent variable and the value predicted by the regression equation.

[35] The NUPs analyzed separately from other businesses the one business that accounted for almost half of the predicted business savings (id.; Exh. NUP-2, at 3-4).

savings, using the data screening and estimation methods described above; but (2) in the interim, use the NUPs' 64.2 percent gross realization rate estimate (id. at 23-24). The NUPs add that BECo's estimate of capacity savings is biased or unreliable because it is based on BECo's problematic energy savings estimate (id. at 23). Accordingly, the NUPs ask that the NUP methodology, together with BECo's load shape data (and better documentation of that data), be applied to estimate capacity savings, pending a BECo re-estimate of capacity savings (id. at 23-24).

ii. The Company

BECo does not dispute the fact that substantial errors exist in its program database (BECo Brief at 17). BECo identifies the failure to include in its database all account numbers for a facility[36] as the primary source of errors and indicates that it has since expanded its efforts to match all account numbers (id.). BECo claims that it adjusted for weather and free riders and assumed that the economic climate was stable over the years of the analysis, but acknowledges that it did not gather data on changes to individual facilities and customer behavior (id. at 17-18). BECo argues that it is no longer possible or is not cost-effective to obtain much of the data on customer behavior and facility changes which the NUPs would have BECo use (id. at 20-21). BECo claims that its 29 percent free-rider adjustment resulted in a conservative estimate of program savings, and therefore, the free-rider adjustment was appropriate (id. at 17-18, citing Exh. BE-M&E-1). The Company notes that a free-rider adjustment that was based on the level of free riders associated with each measure offered and applied to the savings associated with those

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[36] A large facility may have several or many meters, pertaining to different buildings, or even separate portions of a large building.

measures, as the NUPs advocate, would result in higher savings estimates than the Company proposed (id.).[37]

BECo claims that the NUP estimation method actually supports BECo's savings estimates (id. at 19). BECo agrees that the NUP model may incorporate changes in consumption that are not due to the DSM program, but maintains that such changes, or "natural conservation," are analogous to free ridership (id.). Therefore, BECo claims that, if the NUP model is used, the results should not be adjusted for free riders (id.). To support its own estimate, BECo adjusts the NUP results to reflect its analysis of natural conservation, producing two estimated realization rates, both of them slightly higher than BECo's own estimate (id. at 20, citing Exhs. BE-M&E-2 through BE-M&E-6).

c. Analysis and Findings

Regarding the quality of data BECo used to determine savings estimates for the Large C/I Retrofit Program, the record demonstrates that the data for a large fraction of participants in this program reflected predicted or actual changes in electricity use which exceeded the total use of those customers. The Department finds such results to be implausible, and in some cases, impossible. In addition, the record shows that BECo's data were plagued both by data errors (as acknowledged by BECo) and by low signal-to-noise ratios. Moreover, the record does not show that BECo took effective steps to improve the signal-to-noise ratio. Nor does the record support BECo's assumption of a stable economic climate during 1991.[38] For this program, the

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[37] The Company provided an analysis with its brief indicating that free ridership developed on a measure-specific basis rather than a participant-specific basis, as the NUPs advocate, would result in a free ridership adjustment of 24.93 percent (id., citing App. BE-M&E-1).

(continued...)

Department finds that, because of the pervasive and severe data problems, BECo's unscreened data do not constitute a reliable basis for estimating a realization rate.

The record shows that the NUPs have proposed reasonable guidelines for handling data in impact evaluations. The Department recommends these guidelines to the Company for the purposes of future impact evaluations.[39] Further, the Department concurs with the NUPs that data collection efforts, especially for large C/I customers, should focus on participants with large predicted impacts. Therefore, the Department finds that BECo should have collected participant-specific economic data for participants where such data would eliminate much of the noise, but was not remiss in not collecting such data where the remaining noise would still be many times predicted savings. Accordingly, for future impact evaluations of large C/I customers and similar groups of customers, the Department directs the Company to collect participant-specific economic data for participants with substantial absolute or relative predicted savings, and to use other methods and/or surveys to deal with low signal-to-noise ratios for other participants.

Regarding the methodology by which BECo calculated the savings estimates, the record shows that BECo's method of estimating savings based on a median realization rate does not weigh participants according to their expected energy savings, and is significantly affected by the

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[38](...continued)
[38] Instead, the record indicates that participants experienced a reduction in energy use of more than 45 percent at several large facilities, when very small savings were anticipated. This suggests that some large decreases in energy use due primarily to changed economic conditions.

[39] The Department has previously cited the benefits of collecting data on general and firm-specific economic conditions, facility changes, weather-dependent load, and weather in order to reduce the "noise" of year-to-year variations which obscure the "signal" of changes due to a DSM program. Boston Edison Company, D.P.U. 90-335, at 98 (1992).

omission of data. The Department finds that BECo's method inappropriately ignores most of the data about participants' energy use, is not robust, and is vulnerable to bias from changes in consumption that are not related to the ECMs installed. Because of these problems with BECo's method, and because of the severe problems associated with BECo's unscreened data, the Department finds that BECo's energy savings estimate is not sufficiently unbiased. Further, because the record shows that BECo's capacity savings estimate is based directly on its energy savings estimate, the Department finds that BECo's capacity savings estimate is not sufficiently unbiased. Therefore, the Department rejects BECo's savings estimates for this program.

The NUPs presented an alternative calculation that screened out facilities to reduce the impact of missing data, data errors, and large changes in consumption that were unlikely to be due to the program. The record shows that the NUPs' technique weights facilities based on their contribution to total program savings, while limiting the undue influence of outliers and leverage points. The Department finds that the NUPs' method is the best method of estimating savings offered in this case, because it eliminates erroneous and implausible data, and because it weights different observations according to reasonable criteria. Therefore, the Department accepts the NUPs' 64.2 percent estimate of the gross realization rate for this program, as opposed to BECo's 86 percent gross realization rate estimate.

BECo argues that the NUPs' equation used to estimate a realization rate implicitly includes a free-rider adjustment, but the NUPs claim it does not. The Department finds that the NUPs' model accounts for changes in use by participants absent the DSM program, including economic conditions, facility changes, weather, and natural conservation. Natural conservation in the NUP model consists of savings from ECMs that are not offered through the Company's program.

However, the NUPs' model does not address the degree to which ECMs offered through the program, which are the subject of free ridership, would have been installed by non-participants. Thus, the Department agrees with the NUPs' contention that their estimate does not include a free-rider adjustment, and that it is appropriate to apply one.

The record shows that BECo applied a 29 percent lighting free-rider rate to all types of measures offered through the Large C/I Retrofit Program. The record also shows that BECo measured partial free riders but did not account for them in its savings estimates. The NUPs argued that BECo's free-rider adjustment was flawed because it only used data for lighting measures and was based on the number of customers rather than the quantity of savings affected. BECo provided a revised free-rider adjustment to address the NUPs' concerns, but argued that its own free-rider adjustment was more conservative, and therefore more appropriate. The Department finds that, where the data are available, it is appropriate to apply a free-rider adjustment weighted by the technology-specific level of free riders for each technology offered through the program. Further, because participants can represent a large variability of free-ridership (i.e., partial free-ridership to full free-ridership), the Department finds that it is more appropriate to evaluate the quantity of savings affected, rather than the number of participants affected, by free-ridership. Therefore, the Department accepts the adjusted free-rider factor of 24.93 percent provided by BECo.

Accordingly, the Department directs BECo to revise its energy and capacity savings estimates for this program to reflect a 64.2 percent gross realization rate and a 24.93 percent free-rider factor,[40] and to submit the revised savings estimate to the Department in a compliance filing.

The NUPs also offered reasonable methodological guidelines for evaluating savings for a program with a small population and wide variation in savings. The Department recommends these guidelines to the Company for future DSM impact evaluations, including, where appropriate, different methods of analysis for different sample segments.

3. Small Commercial and Industrial Retrofit Program

a. Program Description

The Small C/I Retrofit Program offers rebates for the installation of energy efficient lighting, HVAC, refrigeration, hot water, cooking and process equipment to commercial and industrial customers with peak demands of less than 150 KW (Exh. DPU-36, at 2). The program began in 1989 and had over 1,100 participants by the end of 1990 (id. at 23). The program required no customer co-payment in 1991 and 1992, and achieved the participation of 919 and 814 customers, respectively, in those years (Exh. DPU-50, at 227, 236, 243). The Company reports first true-up annual energy savings estimates of 9,609 megawatt-hours ("MWH") and capacity savings of 3,120 KW for 1992 implementation (Exh. DPU-50, at 236). For program implementation in 1991, the Company reports second true-up annual savings estimates of 7,146

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40 The Department notes that the net realization rate is approximately 48.2 percent, calculated by the 64.2 gross realization rate multiplied by the (1 - 24.93) free-rider factor.

MWH and 1,691 KW (id.). In both of these years, lighting retrofits accounted for approximately 92 percent of the energy savings (id. at 238; Exh. DPU-36, at 35).

b. Impact Evaluation

In order to determine energy savings of 1991 participants, the Company performed both a pre/post billing analysis of participants and non-participants and a conditional demand (regression) analysis, as explained below (Exh. DPU-50, at 232). The Company determined coincident demand impacts of program implementation in 1991 by applying end-use specific load shapes to the net energy savings derived from the billing analysis (id.). The first true-up of energy and capacity savings estimated for 1992 program participants was calculated by applying the gross and net realization rates found for 1991 participants (i.e., ratios of measured savings to original engineering estimates of savings) to the engineering estimates for 1992 participants (id. at 240).

The Company compared the results of the billing analysis to engineering estimates of energy savings based on data contained in the program database to derive a net realization rate of 75 percent (Exhs. DPU-50, at 239-240; DPU-8-20). This percentage was applied to adjusted engineering estimates to determine the first true-up estimate of savings for 1992 participants (id.).[41] For 1992 program implementation, the Company estimates net annualized energy savings of 9,609 MWH, and lifetime energy savings of 144,133 MWH (id. at 236).

The Company determined peak demand impacts by (1) allocating annualized energy savings to end uses in proportion to engineering estimates of savings in each end use, and

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[41] Adjusted engineering estimates were calculated by applying factors for free-ridership and measure removal to tracking system savings estimates (Exh. DPU-50, at 239). These factors resulted from a telephone survey of participants and non-participants in the Small C/I Retrofit Program conducted in 1992 (id.).

(2) applying the estimate of annualized energy savings in each end use to a computer model which used end-use load shape information to distribute the energy savings to hourly demands by season and day type (Exh. DPU-36, at 47-48). The energy savings allocated by this model to the peak hour determined the coincident demand reduction in that hour (id.). The model indicated a net demand reduction of 1.84 KW per participant for both the summer and winter peaks, and a total demand reduction of 1,691 KW for 1991 program implementation (id.; Exh. DPU-50, at 243).

The Company compared the results of its analysis of demand savings to engineering estimates of demand savings based on data contained in the program database to derive a net realization rate of 74.55 percent (Exhs. DPU-50, at 240; DPU-8-20). BECo applied this percentage to the adjusted engineering estimates for 1992 participants to determine the first true-up estimate of demand savings for all 1992 participants (Exh. DPU-50, at 240). For 1992 program implementation, the Company estimated per participant demand savings of 3.83 KW for both summer and winter peaks, and total demand impacts of 3,120 KW (Exh. DPU-50, at 236, 241).

c. Data Quality

The process and impact evaluations of the Small C/I Retrofit Program raise issues regarding the completeness and quality of the data used to determine the energy and demand savings due to this program. The Small C/I Retrofit Program impact evaluation indicated that one major difficulty was estimated versus actual meter read data. Further indications of missing or inaccurate data are contained in the report on the process evaluation of the 1991 Small C/I Retrofit Program (Exh. DPU-35, at 97-115). Among the more serious of the data quality problems listed in this report are the inability of the database to accommodate customers with

multiple account numbers, the frequent absence of information on operating hours of the equipment installed through the program, and other inputs necessary for engineering algorithms (id. at 98-100).

In addition, the process evaluation report documents comparisons between the program database and data from energy survey forms, site visit reports, and customer surveys (Exh. DPU-35 at 109-111). For most participants and for most types of data, the information contained in these various sources was reasonably consistent. However, the evaluation found substantial disagreement between sources on operating hours and quantities of original and replacement equipment (Exh. DPU-35, at 109). Although the report suggests that these discrepancies may be due to changes in data element definitions over time, they gave rise to significant differences in the savings estimates developed from the different data sources (id. at 110).

d. Analysis and Findings

The record indicates that numerous types of data quality problems existed for the Small C/I Retrofit Program as implemented in 1991, and that these problems hindered the impact evaluation of the program. The Department is generally concerned that, in the past, the Company has not collected sufficiently detailed survey data to explain non-program-related changes in energy consumption from year to year. However, the record also contains evidence that the Company has taken steps to correct some of the initial shortcomings of its data collection efforts, and that future M&E filings should incorporate better data. Given the existing data constraints, the Department finds that the Company's evaluation was reasonable, with no apparent bias to the resulting savings estimates. Accordingly, the Department finds the impact evaluation of the Small C/I Retrofit Program to be sufficiently unbiased and precise, and therefore accepts the Company's

estimates of 7,146 MWH and 107,192 MWH respectively as the final annualized and lifetime savings due to the 1991 implementation of the program. The Department also accepts the Company's estimate of 1,691 KW as the coincident demand reduction to program implementation in that year.

The Department, however, expects the Company to improve its ability to collect and evaluate all relevant survey data over time.[42] Specifically, the Department expects the Company to incorporate into its regression analyses information regarding changes in the economy and a firm's productivity (e.g., business output, number of employees, square footage of facilities, equipment operating cycles) in order to improve the accuracy of the Company's energy savings estimates.

4. Commercial and Industrial New Construction Program

a. Description

The C/I New Construction Program provides financial incentives to developers, builders, owners, and/or occupants to install energy-using equipment that exceeds building code standards during new construction and major renovation (Exh. DPU-41, at i).

The impact evaluation used on-site visits to sample 18 out of 49 participating facilities, stratified to include about 90 percent of predicted savings, including all of the largest users (id. at 46-47). The visits counted ECMs and measured wattage and hours of use (two types of end-

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[42] In D.P.U. 90-335 at 98, the Department stated:

> Before gross savings can be derived, savings estimated from before-and-after analyses must be adjusted to account for weather, for customer behavior (including changes such as hours of operation or temperature settings, and non-program related changes in the mix and type of end-use devices), and for C&LM measure performance.

use metering), which were used as inputs to building simulation programs and spreadsheet analyses (id. at 5). Simulation programs were used for more complex measures and measure interactions, such as HVAC systems, while simple spreadsheet analyses were used for efficient motors and most lighting measures (id. at 8).

The study estimated gross energy savings realization rates of 70 percent for 1991 ECMs and 89 percent for 1992 ECMs (id. at 56).[43] BECo provided corresponding estimated realization rates for summer and winter coincident demand savings, which were similar to the energy rates for 1992, but near 60 percent for 1991 (id.). A survey of all participants found three pure free riders and six partial free riders, but the Company concluded that only one participant was truly a free rider (id. at 50-51; Exh. DPU-3-20). The Company determined that, based on a detailed examination of survey responses, focus group discussions, and site-survey information, the remaining full and partial free-riders were interested in implementation of DSM measures because of the Company's programs, i.e., due to spillover effects (id.). BECo reported that all participants indicated that the ECMs installed were still in use (Exh. DPU-41, at 52). The corresponding net energy realization rates were 64 percent for 1991 ECMs and 82 percent for 1992 ECMs, with similar estimates for demand savings (id. at 58). BECo stated that the relative precision of almost all of the realization rates estimated were very near ±10 percent, some more precise and some less (id.).

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[43] These percentages included a gross realization rate of 84.5 percent for thermal energy storage projects (id. at 49).

b. Analysis and Findings

The record shows that, in order to estimate savings, BECo employed end-use metering on a small sample of facilities which represented almost all of the predicted savings. The record shows that BECo used metered data appropriately to estimate savings and that the savings were reported to a high degree of precision. The record indicates a detailed analysis of free riders.

The Department notes that BECo's sample was very well constructed, and that the Company used an extensive quantity of measured data. The Department also notes that the Company was able to achieve a very high precision for most of the reported results. Accordingly, the Department finds that BECo's savings estimates are sufficiently unbiased and precise, and accepts the savings estimates. The Department adds that it expects further activity at appropriate intervals to continue to measure persistence for this program.

5. Commercial and Industrial Remodeling and Equipment Replacement Programs

a. Description

The C/I Remodeling and Equipment Replacement programs have offered incentives since 1990 to partially or fully offset the incremental cost of a customer's upgrade to more energy-efficient equipment (Exh. DPU-19, at ES-1). For 1992, BECo reported savings estimates for the lone participant in the Remodeling program and for 83 participants in the Equipment Replacement Program (Exh. BE-1, at 303 and 327).[44] BECo evaluated these two programs jointly with the Lighting Rebates Program (Exhs. DPU-19, at ES-2; DPU-3-26).

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[44] For 1991, BECo reported savings estimates for two participants in the Remodeling Program and for 137 participants in the Equipment Replacement Program (id. at 307 and 331).

BECo's impact evaluation consisted of a mixture of on-site inspections, engineering algorithms[45] and simulation modeling, and short-term end-use metering, relying primarily on engineering analysis (Exhs. DPU-19, at 2-1; BE-1, at 318). BECo stated that its short-term end-use metering consisted of lighting loggers, which measured the hours of use for approximately one week, at six sites which represented 17 percent of estimated net savings (Exhs. DPU-19, at 2-3, 2-6; DPU-3-7; DPU-11-18). BECo added that in some cases it used billing analysis or short-term end-use metering data for individual premises to calibrate its simulation models (Exh. DPU-11-14). BECo's measurements showed that inspected lights and motors operated almost as many hours as were predicted before the ECMs were installed (Exh. DPU-3-7).

Based on the activities described above, BECo estimated gross energy and demand savings for these programs (Exh. DPU-19, at 3-2 through 3-27). BECo did not report any precision or realization rates attached to its savings estimates for these programs (Exh. BE-1, at 39). However, BECo stated that the gross energy savings for 1992 installations were 35 percent of the planned amount for Equipment Replacement and less than 1 percent of the planned amount for Remodeling (Exh. BE-1, at 304, 327). BECo stated that the 1992 shortfall was due to: (1) fewer participants than expected, (2) lower savings per participant, and (3) adjustments for free riders and persistence (id.). However, BECo reported that net savings for the Equipment Replacement Program's 1991 installations were 8 percent higher than those submitted in last year's evaluation report, balancing savings newly included from lighting rebates with reductions for free riders and persistence (id. at 332-333). BECo similarly reported a

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[45] BECo described the engineering algorithms in detail (Exhs. DPU-19, at 2-11 through 2-16; DPU-3-8; DPU-3-9).

23 percent increase from last year's evaluation report for savings from 1991 installations in the much smaller Remodeling program, after including a project which was not previously included (id. at 307-308).

BECo used the 29 percent free-rider rate from the Large C/I Retrofit Program for the Lighting Rebate program (id. at 326). For the other two programs, BECo used on-site interviews to identify 14 of 41 projects as potential free riders, but found that many of these customers were the result of spillover (Exh. DPU-19, at 3-3). BECo took credit for varying degrees of spillover to offset pure and partial free riders identified, leaving a variety of participant-specific free-rider factors (id.; Exh. DPU-3-12). BECo used these free-rider factors to adjust its savings estimates from gross to net (Exh. BE-1, at 302).

To estimate persistence for Lighting Rebates, BECo used the 13 percent removal rate from the Small C/I Retrofit Program (id. at 326). For persistence in the other two programs, BECo identified one facility that had closed since its ECMs were installed and a second facility that was scheduled to close in a year (1993 or 1994) (Exh. DPU-19, at 3-3). BECo set lifetime savings equal to first-year savings for the first facility, but did not reduce projected lifetime savings at the second facility (id.). BECo stated that it does not intend to revise its savings estimates for current ECM installations after the first two years to reflect the results of future persistence findings, citing the importance of not holding its incentive at risk for the entire expected measure life (Exh. DPU-11-20).

b. Analysis and Findings

The record shows that BECo used a variety of evaluation techniques for the C/I Remodeling and Equipment Replacement programs, including measurements of equipment

operating hours at six sites. The record shows that BECo overestimated operating hours only slightly at the six sites, and the small sample does not permit an inference that a general pattern of overestimation of operating hours in this program. The record shows that BECo estimated free riders, net of spillover effects, on a participant-specific basis. The record shows that BECo adjusted its savings estimates for persistence to date, but has not projected its persistence findings to the future, when at least one other facility is scheduled to close.

The record does not show significant bias in BECo's methods for estimating gross annual savings. For the purposes of the instant proceeding, the Department will accept BECo's treatment of free riders for these programs.[46] The Department also accepts BECo's treatment of persistence for these programs in this case. In light of the above, the Department finds that BECo's savings estimates for the C/I Remodeling and Equipment Replacement programs are sufficiently unbiased and, accordingly, accepts them.

However, the Department expects some improvements in future evaluations of these programs. Most of BECo's savings estimates for these programs are not measured; accordingly, the Department directs BECo to use measurements to estimate savings for a much larger fraction of its ECMs in its future evaluations of these programs. BECo should report realization rates and the precision of its measured savings for these programs in its future evaluations. The Department directs the Company to continue its efforts to estimate spillover effects in more formal ways where possible and cost-effective. The Department directs the Company in its future

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[46] The Department recognizes that the issue of spillover is being analyzed presently by a consortium of electric utilities in Massachusetts and Rhode Island and that better methodologies to evaluate spillover will evolve over time.

evaluations to factor into its persistence estimates an explicit estimate of the rate of future facility closings. The Department reiterates that the Company should conduct follow-up surveys at appropriate intervals, and adjust expected ECM lives accordingly, basing such adjustments on both physical and economic obsolescence of installed measures.

6. Design Plus Program

The Company claimed that the Design Plus Program accrued savings during 1991 that were equal to the Company's original estimates for the program (Exh. BE-1, at 19-A, 67). BECo, however, did not supply any evaluation of its claimed savings for this program. The Department notes that impact evaluations of most programs have shown that actual savings are less than predicted savings. Thus, the Department finds that actual savings for Design Plus are likely to be less than the savings BECo claims, i.e., that BECo's estimates are biased upward. Accordingly, the Department rejects BECo's savings claim for this program. The Department notes that the Design Plus program targets a similar market sector and list of end uses as the Company's C/I New Construction Program. The Department also notes that we have found the Company's evaluation of the C/I New Construction Program to be satisfactory. Therefore, the Department directs BECo to revise its claimed savings for the Design Plus Program using the 1991 realization rate for the C/I New Construction Program, and to revise its incentive and lost base revenue calculations accordingly.

7. Load Management Programs

a. Description

During the period 1987 through 1992, BECo operated three load management programs, which were designed to reduce demand when system demand for power is high: Boston Edison

Energy Cooperative ("BEEC"), Generator Assistance at Peak ("GAP"), and Time of Use Load Curtailment ("TOULC") (Exhs. BE-1, at 353; DPU-3-16). Each program offered participants (medium to large C/I customers) $10 for each KW of contracted load curtailment in any month during which load management measures were activated (Exh. BE-1, at 353). During those six years, the three programs were activated 94 times[47] (Exh. DPU-24, at IV-5 through IV-9). BECo used the same methodology to estimate the savings due to each program for the summer and winter curtailment days in each year (Exh. DPU-24, at I-1).

Using data from 15-minute interval demand meters, BECo estimated net energy and capacity savings by a three-step process (Exhs. BE-1, at 357; DPU-24, at II-3). First, for each curtailment hour, BECo estimated the gross savings for 244 sampled participants[48] as the difference between predicted load and recorded load (Exh. DPU-24, at III-13, II-6). In order to predict the electricity use that would have occurred during curtailment hours, BECo employed regression analyses using data about weather and other factors from ten non-curtailment, non-holiday weekdays in each of the six years (60 days in all) which had the most extreme temperatures (hottest days in summer, coldest days in winter) (id. at II-3, III-1 through III-12). Second, for each curtailed hour, BECo used a similar technique to estimate the gross capacity and energy savings for a sample of 88 non-participants, chosen from customers that were eligible to participate (id.). Third, to determine net savings for each curtailment hour (for each program), BECo subtracted gross savings by non-participants from gross savings by participants, after

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[47] These comprised 47 different days, because more than one program was often activated on the same day, sometimes for different numbers of hours (Exh. BE-1, App. A).

[48] Sampled participants included all participants with usable data, and were distributed across all three programs (Exh. DPU-24, at II-3, II-6).

adjusting for differences in scale (amount of consumption) between the two groups (id. at III-15, III-16).

BECo estimated net program demand savings to be positive for all but four of the 94 days during which a program was implemented, and negative for the other four days (id., App. A). BECo noted that many of the maximum load reductions were not on days of BECo or NEPOOL summer or winter peak (id. at IV-12). BECo claimed its savings based on the maximum load reduction achieved during each season, resulting in a total of 23 demand savings estimates (reflecting various implementations of the three programs across the two seasons of the six years) (id. at IV-4 through IV-9). BECo compared these savings estimates based on measurements to its 21 corresponding original estimates of achieved savings,[49] resulting in 21 realization rates (Exh. DPU-3-16). All 21 realization rates were positive and the median realization rate was 92 percent (id.). BECo simultaneously developed energy savings estimates with overall realization rates of 59 percent for BEEC, 52 percent for GAP, and 23 percent for TOULC (id.). BECo also reported the precision of its savings estimates for each curtailment hour for each program (Exh. DPU-24, App. B).[50]

b. Positions of the Parties

i. NUPs

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[49] BECo did not provide original savings estimates for 1992 for the BEEC or GAP programs (Exh. DPU-3-16).

[50] For the respective hours in the most recent curtailment year during which the maximum estimated load reductions were achieved, the precision (at the 90 percent confidence level) of the demand savings estimate was determined to be ±97 percent for BEEC, ±104 percent for GAP, and ±131 percent for TOULC (Exh. BE-1, at 357).

The NUPs contend that BECo should not be allowed to claim savings for the TOULC program in 1991, since the program was not activated during that year, and that BECo should not be allowed to claim any associated lost base revenues (NUP Brief at 32). The NUPs also suggest that BECo should develop a methodology to value, "on a life cycle basis," load management programs that are not activated in a given year, yet represent a contingency resource (id.).

ii. BECo

BECo agrees with the NUPs that the Company should not have claimed lost base revenues for a year when a load management program was not called upon (BECo Brief at 24). BECo states that program goals and claimed savings for load management programs should be treated consistently (id.). To do this, BECo proposes that in years when a load management program is not activated, the Company should claim the potential savings from the contracted load resource available from a program (id.). BECo argues that, in this way, its incentive and lost base revenues will not be automatically penalized (id. at 25).

c. Analysis and Findings

The record shows that BECo has used a great deal of load data in evaluating the BEEC, GAP and TOULC programs. The record shows that BECo used weather and other data in a sophisticated manner to account for what would have happened absent curtailments, for both participants and non-participants. The record shows that BECo estimated the precision of its savings estimate for each program for each curtailed hour.

The Department finds that BECo's treatment of the data was very thorough and that BECo took great care to account for what would have happened absent the program. These facts, including the intensive use of measured data, give us confidence that BECo's savings

estimates are unbiased. Accordingly, the Department finds that the savings estimates are sufficiently unbiased and are measured to sufficient precision, and accepts the savings estimates.

However, the record shows that many of the maximum load reductions did not occur during peak demand days. Accordingly, the Department directs BECo in its next evaluation filing for load management programs to explain why it is appropriate to claim the maximum capacity savings achieved during a season rather than the capacity savings achieved at the time of system peak.

The Department agrees with the NUPs and BECo that it is inappropriate to claim demand or energy savings for periods in which a program is not activated and thus achieves none. The Department also agrees with BECo that it is appropriate to treat the reductions which could have been achieved by curtailing load, even though the load was not curtailed in a particular year, as a potential resource. This is similar to counting as a potential resource a combustion turbine which is available but idle during a peak season. The Department also agrees with BECo that a company should not be penalized automatically for non-activation of a load management program. However, it appears to the Department that BECo's proposal would allow it to claim savings that did not occur and recovery of base revenues that were not lost. Therefore, when a load management program is not activated, rather than adjusting the savings to match the goals, as BECo proposes, the Department finds it appropriate to adjust the affected goal to match the actual savings, for purposes of calculating incentives; i.e., to set the goal for that year, after the fact, to zero to match the zero savings corresponding to non-activation. Accordingly, the Department directs BECo to revise its claimed savings and lost base revenue calculation for the 1991 TOULC program, and lost base revenue reconciliation for the 1992 TOULC program,

consistent with its non-activation in those years. Further, in order not to penalize the Company inappropriately, the Department directs the Company to revise its yearly program impact goal to match the actual savings of zero for any load management program that was not activated in a year, and to revise its incentive structures and proposed incentive accordingly.[51,52]

8. Cool Storage

a. Description

The Cool Storage program reduces the Company's capacity requirements by shifting air conditioning load from peak hours to off-peak hours through the use of thermal storage systems (Exh. BE-1, at 347). Three BECo customers participated in 1991 by installing thermal storage; no participants were added in 1992 (id. at 348).

The impact evaluation sampled the two participants that represented over 90 percent of the estimated demand savings (id. at 349). To estimate savings, the impact evaluation used end-use metering (separately for watts and hours), equipment specifications, building usage information, and data from building managers as inputs into engineering calculations (id.).

Based on its metering and analysis, BECo estimated that the program actually saved 1.1 MW, which was 74 percent of the predicted summer demand savings, with a precision of ±9 percent at the 90 percent confidence level (id. at 349, 351).[53] Based on its process evaluation

[51] The Department continues to recognize that expenses incurred to maintain a load curtailment program in readiness are appropriate, as long as the program is cost-effective compared to other ways of meeting potential peak loads, and as long as there is a significant likelihood that peak loads requiring curtailment will occur.

[52] Consistent with this discussion, the Department will consider a reduction in projected savings due to load management programs in the future when calculating lost base revenue recovery at the start of a program year, in order to protect ratepayers from paying up front for lost revenues which are never realized.

(continued...)

survey, BECo determined that there were no free riders or spillover for this program, and that persistence was 100 percent (id. at 348).

b. Analysis and Findings

The record shows that BECo used a well-designed sample, combined with survey data and a variety of end-use metering to estimate savings. The record shows that the savings were estimated with precision, and that BECo adjusted appropriately for free riders, persistence, and other factors. Therefore, the Department finds that the estimated savings for this program are sufficiently unbiased and precise. Accordingly, the Department accepts the savings estimates for this program.

D. Residential Programs

1. Residential Electric Heat/High-Use Program

a. Program Description

The Residential Electric Heat/High Use ("REH") Program targets residential customers who consume at least 10,000 KWH per year (Exh. DPU-50, at 160). The target market includes single-family and up to four-unit multifamily buildings (id.). The program offers direct installation of energy efficiency measures, as well as technical assistance in operating, maintaining, and replacing the measures (id.). Measures installed through the program affect lighting, HVAC, envelope (air sealing, storm windows, and insulation), and hot water (id.).

BECo estimates that the 541 customers who participated in the program in 1991 will save 1,217,616 KWH and 364 KW (in winter) annually and 20,974,867 KWH over the lives of the

[53](...continued)
[53] The evaluation also estimated that the program increased energy use by 275 MWH, compared to the expected change of zero MWH (Exh. BE-1, at 351).

measures (Exh. DPU-31, at 4-32). BECo proposes these savings estimates as the second and final true-up of 1991 program implementation (Exh. DPU-50, at 167-169). In 1992, the program had 583 participants (id.). The Company's proposed first true-up savings estimate for 1992 is 1,886,448 KWH and 583 KW (winter) annually, and 31,386,257 KWH over the lives of the measures (id.).

b. Impact Evaluation

The Company used multiple regression billing analyses to estimate both gross and net energy savings for 1991 participants in the REH Program (Exh. DPU-31 at 4-1, 4-2). For both estimates, a customer's energy consumption in 1992 (the "post-installation period") was compared to consumption in 1990 (the "pre-installation period") (id. at 4-13).

Prior to running the regression models, the Company screened the program data and billing data for participants and non-participants, to ensure that it was accurate and complete (id. at 4-12 through 4-14). Among the screens employed by the Company was one which eliminated participants from the regression sample if the engineering estimates of savings for these participants were "determined to be out of range in terms of reasonableness" or "radically different" from those of other participants with the same measures (id.). Four participants appear to have been dropped from the regression analysis as a result of this screen (id. at 4-13, 4-14).

The gross savings model considered only the change in participants' consumption levels between the pre- and post-installation periods. The statistical model developed to estimate gross energy savings included as explanatory variables (1) the engineering estimate of space-heating savings for each participant from the program tracking system;[54] (2) the engineering estimate of

(continued...)

savings from other end-uses;[55] (3) each participant's pre-installation level of energy consumption; (4) heating degree-days and cooling degree-days; and (5) dummy variables for each quarter of the calendar year (to capture seasonal variation not captured by weather data) (id. at 4-3). The model resulted in a realization rate of 103 percent for space heating energy savings and 61 percent for non-space-heating energy savings (id. at 4-19).

To calculate net savings, the change in consumption between the pre- and post-installation periods for the same group of participants included in the gross savings analysis was compared to the change in consumption over the same time period for a group of 589 customers who were eligible for the program but had not participated in it (id. at 4-20 through 4-26). The objective of including non-participants was to control for the savings associated with implementation of the program, as well as for factors which affect energy consumption but which are unrelated to program participation. The impact evaluation report contains no indication that any analysis was performed to ensure that the participants and non-participants included in the net savings model had comparable levels of energy consumption in the pre-installation period. The net savings model developed the estimate of annualized energy savings cited above as the Company's second true-up for program implementation in 1991 (id. at 4-32; Exh. DPU-51, at 5).

To develop the first true-up estimate of gross savings for 1992 participants, the Company applied the realization rates for space-heating and non-space-heating measures resulting from the

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[54](...continued)

[54] Space heating measures included air sealing, HVAC tune-up and cleaning, insulation, set-back thermostats, and window treatments (Exh. DPU-31, at 4-3).

[55] Non-space heating measures included fluorescent lamps and fixtures, refrigerator coil cleaning, water tank and pipe insulation, and water conserving showerheads and faucet aerators (Exh. DPU-31, at 4-3).

gross savings analysis to the engineering estimates for 1992 installations of these measures (Exh. DPU-8-28). The Company converted this to an estimate of net savings for 1992 by applying the ratio of 1991 net savings to 1991 gross savings (id.).

For both years, BECo calculated the coincident demand reductions due to the program by using its benefit-cost model (Exh. DPU-8-32). This model allocated annualized energy savings across seasons (summer, winter, and spring/fall), day-types (weekdays, weekends, and high/peak days), and peak periods (id.). Energy savings allocated to the hours most likely to coincide with the Company's system peak were averaged to approximate the coincident demand reduction (id.).

c. Analysis and Findings

The record demonstrates that the Company has based its estimate of energy savings on the results of a billing analysis of 310 participants and 589 non-participants. The Department finds the multiple regression billing analysis conducted by the Company to be generally acceptable. However, two aspects of this analysis require further discussion. First, the Department finds that the Company has not adequately supported its practice of eliminating participants from the regression sample because the energy savings associated with such participants were considered to be outside of a reasonable range. As an initial matter, the Department finds the description of this data screen in the evaluation report to be vague. There is no description of the process or criteria used to determine that an engineering estimate was "out of range in terms of reasonableness" or "radically different." Furthermore, the Company has submitted no evidence that such cases are not representative of the population of participants. The purpose of the regression analyses was to develop savings estimates for the sample of participants that could be applied to the greater population of program participants. It may very well be the case that such

outlying engineering estimates exist in the participant population with the same frequency as they do in the participant sample. As a general matter, excluding such cases from the analysis may result in biased estimates of realization rates and savings.

In the instant case, the record indicates that only four out of 535 participants were eliminated from the analysis as a result of this screen. The Department finds that any bias introduced by this screen is therefore likely to be small, and does not warrant a re-analysis of the data. However, the Department expects the Company to provide thorough justification for all data screening procedures used to determine program savings.

Secondly, the Company has provided very little information regarding the selection of the comparison group. In particular, although the Company has presented numerous measures of the comparability between the sample of 1991 participants used in the analysis and the population of 1991 participants, it has presented no analysis of the comparability of the non-participant group to the participant sample. However, the record contains no evidence suggesting that the selection of the non-participant comparison group has resulted in a biased estimate of savings. The Department will accept, as part of the instant proceeding, the Company's estimates of savings from this program.

Accordingly, the Department approves as final the Company's estimate of 1,217,616 KWH annualized energy savings and 364 KW for 1991 and the first true-up estimate of 1,886,448 KWH and 583 KW for 1992. In addition, the Department will accept as final the estimate of lifetime energy savings for 1991 implementation contained in the final report on the impact evaluation, i.e., 20,974,867 KWH. The Department also accepts the estimate of 31,386,257 KWH contained in the evaluation report as the first true-up estimate of lifetime

energy savings due to 1992 program implementation.

In all future billing analyses the Department directs the Company to include evidence that the selected comparison group reasonably reflects the characteristics of the participant group in all future billing analyses. The Department expects that such a showing would include, at a minimum, a comparison of the distribution of annualized pre-installation energy consumption for the two groups.

2. Energy Crafted Home Residential New Construction Program

a. Program Description

The Company's Energy Crafted Home ("ECH") Program was developed in cooperation with other electric utilities in the Commonwealth to promote energy efficiency in residential new construction (Exh. DPU-37, at 2-1). The program provided training, technical assistance, and financial incentives to builders to design the homes they build to be energy efficient and to incorporate certain energy conservation measures (Exh. DPU-50, at 142). The program was initially designed to be entirely performance-based, meaning that in order to qualify for the financial incentive offered by the program, builders would have to design and build homes that did not exceed a pre-specified threshold level of energy consumption (id.). A home's compliance with this threshold was determined by modeling the home's performance using a specially designed computer model (id.). Although the program was intended primarily to address electrically-heated single- and multi-family new construction, limited incentives were available to homes heated by fossil fuels to cover the incremental costs of installing efficient lighting (Exh. DPU-37, at 1-1). In 1991, 84 fossil fuel-heated multi-family units and nine electrically heated multi-family units participated in the program (Exh. BE-50, at 153). The 27 program participants in 1992

included 24 fossil fuel-heated multi-family units, two single-family fossil fuel-heated homes and one single-family electrically-heated home (id.).

BECo terminated implementation of the ECH program in July 1993. The Company determined that the program was not cost-effective based on savings estimates developed through its impact evaluation. As an alternative for this customer sector, Amendment 3 to the 1992 Settlement provided that the Company would develop a program design for a Home Energy Rebate ("HER") Program, which would be reviewed by the NUPs and subsequently submitted to the Department for its approval. The HER program would be designed to provide prescriptive rebates for specific energy efficiency improvements in the residential new construction, remodeling and equipment replacement markets.[56]

b. Program Evaluation

The impact evaluation conducted by the Company studied the energy consumption characteristics of 108 multi-family dwelling units heated by fossil fuel, nine electrically-heated multi-family dwelling units, two fossil-fuel-heated single-family homes, and one single-family electrically-heated home (Exh. DPU-37). All of these dwelling units participated in the program in 1991 and 1992 (id.). The Company employed both engineering analysis and billing analysis to estimate program impacts and presented savings estimates of 15,830 annualized and 379,920 lifetime KWH and 120 KW-years as the second and final look at 1991 program impacts and 6,914

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[56] This program design was submitted in response to a Department information request (See Exh. DPU 4-4).

annualized and 172,966 lifetime KWH and 25 KW-years as the first look estimate of savings for the 1992 implementation of the ECH program (id.).

i. Engineering Analysis

The engineering analysis employed a computer model to simulate the "as-built" energy consumption of participating dwelling units as well as the energy consumption of similar units built in compliance with the applicable building code but not to the energy efficiency standards required for program compliance (id. at 3-1). The engineering estimate of savings was the difference in energy consumption between these simulations (id.). The engineering analysis was informed by spot meter readings of furnace blower fans and ventilation fans, lighting hours of use as determined by light loggers, and air infiltration rates as determined by blower door tests (id.).

ii. Billing Analysis

Since this program addressed new construction, there is typically no pre-treatment energy consumption data available on which to base a billing analysis of program energy savings (id. at 4-1). For this reason, the Department has not required billing analyses of DSM programs addressing new construction. However, in this case, the Company was able to conduct a billing analysis because the fossil fuel-heated multi-family units included in the evaluation were easily comparable to identical non-participating units in the same building complex and built by the same developer (Exh. DPU-37, at 4-1 to 4-2).

The billing analysis examined the billing data of multi-family fossil fuel-heated units and building common areas participating in the program in 1991 and 1992. Only those units which were occupied and for which there was a complete billing history for the twelve-month study period commencing in October 1991 were included in the billing analysis (id.). The final sample

used in the billing analysis consisted of 43 participants (39 apartments and four common areas) and 63 non-participants (56 apartments and seven common areas) (id.).

The billing analysis adjusted actual participant and non-participant billing data to reflect long-run average weather conditions and resulted in an average savings estimate of 377 KWH per participant per year (id. at 4-8). A similar analysis was applied to the common areas of participating and non-participating buildings. This analysis indicated increased consumption in the common areas of participating buildings of an average of 3,022 KWH/year or 252 KWH/year per apartment (id.). Thus the net weather-adjusted savings per apartment was 125 KWH/year (id. at 4-8, 4-9). The relative precision of this savings estimate is ± 162.9 percent at 90 percent confidence (id.).

c. Positions of the Parties

i. The Non-Utility Parties

The NUPs state that they are concerned that the Company based its decision to terminate the ECH Program on an evaluation of atypical projects which did not credit the program with its full impacts (NUP Brief at 34). They state further that the HER program is inadequate to minimize lost opportunities for savings in new residential construction (id.). The NUPs state that the program design submitted by the Company for the HER Program was not a joint filing, and that their brief is the first opportunity they have had to comment on the evaluation of the ECH Program, the decision to terminate that program, and the proposed design for the HER Program (id.).

(A) Impact Evaluation of the ECH Program

The NUPs argue that the Company's impact evaluation of the ECH program is seriously flawed, and that its decision to terminate the ECH program is therefore inappropriate (id. at 35). The NUPs claim that the participant samples used in the ECH impact evaluation were extremely small and not representative of the dwellings and electric heating systems the Company projects will be built in its service area (id.). The NUPs support this contention by referring to the fact that the ECH impact evaluation investigated only one newly constructed single-family, electrically heated home and an existing nine-unit multi-family, electrically heated building that had undergone renovation (id.). According to the NUPs, the single-family electrically heated home is atypical both in its size and in its use of a groundwater-source heat pump. The NUPs state that very few of the 14,000 new homes the Company projects will be built in its service area by the year 2000 will use groundwater-source heat pumps (id. at 35-36). The NUPs are also critical of the Company's inclusion of the renovated multifamily building in the impact evaluation, stating that such buildings are not part of the target market for this program, and that they cannot be considered representative of new multifamily construction (id.).

In addition to their concerns regarding the size and representative nature of the samples used in the ECH impact evaluation, the NUPs raise four criticisms of the evaluation methodology (id. at 36-37). First, the NUPs argue that the Company's estimates of the incremental costs of the measures installed by program participants are inaccurate, unrepresentative, and undocumented (id. at 36-37; NUP Reply Brief at 26).

The NUPs' second criticism of the ECH impact evaluation regards the Company's reduction by 80 percent of the energy savings estimate in the single-family home to reflect

performance of the heat pump (id. at 37). The NUPs argue that this reduction would not be appropriate for homes heated by electric resistance heat (id.). According to the NUPs, such homes would have four times the energy savings reported in the ECH evaluation (id.).

The NUPs' third criticism concerns statements in the ECH impact evaluation that the program requires continuous mechanical ventilation (id. at 37-38). According to the NUPs, the ECH program requires only that mechanical ventilation equipment capable of continuous operation be installed, but not that such equipment actually be operated continuously (id.). The NUPs argue that by modeling continuous ventilation in the savings calculation, the heating and cooling loads and the energy required to operate ventilation fans are artificially high, leading to savings estimates that are too low (id.). In addition, the NUPs argue that by assuming that all homes participating in the ECH program in the future would use the energy intensive ventilation fan used in the single-family electrically-heated home, and by assuming that this fan was operated solely for the purpose of ventilation (ignoring the fan's operation to deliver heating and cooling to the home), the impact evaluation results in an energy savings estimate that is biased downward (id.).

The NUPs final criticism of the ECH impact evaluation is that it fails to quantify or investigate program spillover effects, which the NUPs suggest may be substantial (NUP Brief at 38).

These criticisms of the Company's ECH impact evaluation lead the NUPs to conclude that the Company's assessment of the cost-effectiveness of the ECH program is wrong and prematurely judged, and does not justify the termination of the program (id. at 39).

The NUPs argue that the performance component of the ECH program could be delivered cost-effectively, provided certain program design modifications are implemented (id.). Specifically, the NUPs suggest that the program be refocused on electrically-heated single and multi-family new construction sub-markets, and that for the multifamily sector, ECH performance standards be revised to address the characteristics of such buildings (id.). According to the NUPs, accurate accounting of program costs and savings would clearly result in a program benefit-cost ratio greater than 1.0 for single-family homes (id.).

According to the NUPs, their proposed modifications to the ECH program design would allow the Company to achieve savings opportunities the NUPs claim will otherwise be lost (id. at 42). In addition, the NUPs claim that retaining the ECH program will protect the Company's credibility with the other electric utilities which sponsor the ECH program, and with the building community, which they claim will be important to the success of any market-driven program (id.). Finally, for both single- and multi-family markets, the NUPs state that the Company should ensure that electric efficiency measures can be delivered in conjunction with any energy efficiency program for new construction developed by gas utilities in the Commonwealth (id. at 43).

In summary, the NUPs argue that the ECH impact evaluation is flawed because participant samples are too small and unrepresentative of the projected market, and because both program costs and savings estimates developed by the evaluation are inaccurate (NUP Brief at 43-44). The NUPs state their belief that given the size of the new construction market for electrically heated homes forecast by the Company, a prudently redesigned ECH program together with a program element targeting multi-family new construction could be cost-effective, particularly if program spillover effects are considered (id.). The NUPs argue that the Department should reject

the flawed ECH impact evaluation as unrepresentative of typical new electric heat construction projects (id.).

(B) Design of the HER Program

The NUPs argue that the more than 14,000 electrically-heated dwellings projected to be built in BECo's service area during the next seven years present a significant opportunity to influence construction practices of builders which, in turn, could lead to market transformation and produce large benefits to society at very low cost to ratepayers (NUP Brief at 39-42). According to the NUPs, the HER Program proposed by the Company would miss much of the energy savings targeted by the Energy Crafted Home program because (1) while it does offer a fairly complete list of prescriptive technology rebates, the HER Program fails to address energy savings that can be achieved cost-effectively through modifications to a home's design; and (2) the HER Program fails to address air infiltration, which, according to the NUPs, accounts for about half of the savings estimated for the ECH program (id.). The NUPs state that it is surprising that the Company determined that air sealing was not cost-effective for the HER Program, when it was determined to be cost-effective in the impact evaluation of the REH Program (NUP Reply Brief at 27-28).

The NUPs reject the Company's argument that the design of the HER Program is outside the scope of this proceeding because this argument ignores the fact that the HER Program design was submitted unilaterally by the Company (NUP Reply Brief at 24). According to the NUPs, the Company ignored their comments on a draft HER program design (id.). The NUPs view this proceeding as their only opportunity to raise issues regarding the design of the HER program (id.).

ii. The Company

The Company asserts that the issues regarding the Energy Crafted Home Program raised by the NUPs on brief are relevant to program design, not monitoring and evaluation, and accordingly are outside the scope of this proceeding (Company Brief at 26). The Company further argues that changes to its DSM program for new residential construction were approved by the Department in its approval of Amendment 3 to the 1992 Settlement (id.). Despite these assertions, the Company responds to several of the issues raised by the NUPs.

The Company contends that its decision to terminate the performance component of the ECH Program in favor of the solely prescriptive rebates offered by the HER Program was reasonable and appropriate (Company Brief at 26). The Company states that it would have been imprudent to not terminate the ECH Program in light of its impact evaluation, which indicated that the program was not cost-effective (id.).

Responding to the NUPs' suggestion that the ECH Program be redesigned to target only single family electrically heated homes, the Company argues that this would be highly impractical and is without merit (Company Brief at 27). The Company states that the 0.42 benefit-cost ratio for single-family electrically-heated homes indicated by the impact evaluation includes no administrative costs, which are particularly high for the custom approach offered by the ECH program (id.). The Company cites record evidence as support for its decision, and states that the NUPs have presented no evidence supporting their contention that the program can be redesigned to be cost-effective (id., citing Exhs. DPU-50, at 22, 142-159; DPU-37; DPU-38).

In response to the NUPs' argument that the Company underestimates potential energy savings in the single-family market by assuming that the average heating system efficiency in new

homes will equal that of the groundwater-source heat pump installed in the single-family electrically-heated home studied by the impact evaluation, the Company agrees that savings from thermal and air sealing conservation measures would be higher for homes with lower efficiency heating units, but argues that this increase would be offset by higher energy usage for mechanical ventilation (id. at 27-28). The Company also agrees with the NUPs that compliance costs for the average home may be lower than the home studied by the impact evaluation, but argues that savings would also be lower in average homes (id.). The Company contends that even if the compliance costs were too high and savings estimates too low for the average home, it is unlikely that the benefit/cost ratio would reach 1.0, given the low ratios found for 1991 and 1992 (id. at 28).

The Company states its agreement with the NUPs that it is important to target the residential new construction market, which, according to the Company, is the motivation behind the HER Program (id. at 28). The Company also responds to the NUPs' contention that the Company used insufficient samples in its impact evaluation of the ECH program by stating that it used a virtual census of 1991 and 1992 program participants (id. at 29).

With regard to the NUPs' arguments about continuous mechanical ventilation, the Company states that, regardless of actual program requirements, the ECH impact evaluation properly reflects the fact that all 1991 and 1992 participants installed continuous mechanical ventilation (id. at 29). In response to the NUPs' criticism of the compliance costs used in the Company's determination that the ECH program is not cost-effective, the Company replies that the costs it used were determined by its evaluation consultant through survey responses, discussions with implementation personnel, and file information (id. at 29). The Company

contends that despite the NUPs' statements that the ECH impact evaluation contains significant flaws, the NUPs did not identify any flaws in the evaluation (id. at 30). The Company characterizes the NUPs' criticisms as disagreements over the Company's judgements or decisions, rather than flaws in the analysis of program impacts (id.).

With regard to the NUPs' contention that air sealing measures should be included in the HER Program because they offer a significant energy saving opportunity, the Company states that air infiltration measures were not included in the program because of their high cost of delivery and verification compared to the potential savings they offer (id. at 30). The Company states that most of the units studied in the ECH impact evaluation failed to meet program requirements for air infiltration, and that the evaluation found little difference in infiltration levels between the base case and the as-built units (id. at 30).

In response to the NUPs' criticism that the ECH impact evaluation did not quantify spillover effects of the program, the Company states that the evaluation did not attempt to study all potential market effects from the program, but was intended to provide a first estimate of savings for 1991 and 1992 participants (id. at 31). The Company also states that it is currently involved in a joint utility study that includes the NUPs to determine net program savings (id.).

The Company responds to the NUPs' suggestion that implementation of all residential new construction programs be coordinated with any new construction programs developed by gas utilities by stating that it has no obligation to address fossil fuel savings through its DSM programs (id.). The Company claims that many attempts were made by the electric utilities implementing the ECH Program to collaborate with local gas utilities, but according to the

Company, these efforts were never successful because of "a lack of enthusiasm" on the part of the gas companies (id.).

d. Analysis and Findings

The parties have raised two distinct sets of issues regarding residential new construction programs in their briefs. The first set of issues addresses the quality of the impact evaluation of the ECH Program and the proper interpretation of that evaluation. The second set of issues addresses the design of the HER Program. The NUPs make numerous criticisms of the ECH impact evaluation, argue that the ECH Program should be redesigned rather than terminated, and seek to modify the design of the HER Program. The Company defends its evaluation of the ECH Program and its resulting decision to terminate that program, and contends that the NUPs' arguments regarding the design of the HER Program are beyond the scope of this monitoring and evaluation proceeding. Before addressing the substantive issues raised by the parties, the Department will first address the procedural question of what issues are properly before it in this proceeding.

The Company argues that because this proceeding is intended to investigate its monitoring and evaluation efforts, issues regarding program design are generally beyond its scope. The Department disagrees with this opinion. One of the primary purposes of program evaluation is to determine the effectiveness of program delivery and to identify ways in which that delivery can be improved. It is a company's responsibility to interpret evaluation results and to modify program design accordingly. It is the Department's responsibility to ensure that utilities are fulfilling their responsibility to incorporate the lessons offered by program evaluations. There can be no question, therefore, that issues of program design may appropriately be raised and addressed in

monitoring and evaluation proceedings, to the extent that such issues arise from the findings of program evaluations. The Department does agree, however, that program design issues which do not arise from the findings of program evaluation are not ripe for consideration in monitoring and evaluation proceedings. Such issues are appropriately raised in proceedings in which the Department authorizes program expenditures.

In the instant case, the NUPs make numerous arguments about the insufficiency of the evaluation samples and the inapplicability of evaluation results to the primary target market for the ECH program, namely, electrically-heated homes. The NUPs conclude that the Company's decision to terminate the ECH program was premature, and argue that the program should be redesigned to target only single-family electrically-heated homes. The record clearly supports the NUPs' contention that a large majority of the homes which participated in the ECH Program in 1991 and 1992 are not representative of the type of homes for which the program was primarily designed. The Department finds it unlikely, therefore, that the patterns of electricity consumption and savings found in the homes sampled by the evaluation are representative of the characteristics of the types of homes for which the program was designed. For these reasons, the Department finds that the results of the Company's impact evaluation have little relevance to the design of a program targeting electrically heated new residential construction.

Because the results of the ECH impact evaluation cannot meaningfully be applied to the design of a residential new construction program targeting electrically heated homes, the Department finds that arguments regarding the interpretation of evaluation results and their application for program design are inappropriate in this case. As noted above, program design issues will be considered in monitoring and evaluation proceedings only to the extent that

evaluation results have direct implications for program design. Accordingly, the Department will not address the NUPs' proposal for the redesign of the ECH Program. The Department does note, however, that the record in this proceeding neither supports nor weakens the justification for the Company's decision to terminate the ECH program. This issue shall be examined in the next proceeding authorizing expenditures on DSM programs.

With regard to the design of the HER Program, the Department finds that the same logic applies. Accordingly, the Department will not address this issue here. However, the Department notes that when Amendment 3 to the 1992 Settlement was filed in November of 1993, the Company's implementation of the ECH Program had been halted for at least two months. Amendment 3 specifies very clearly that the HER Program which replaces the ECH Program will be an entirely prescriptive program. Therefore, when the NUPs signed Amendment 3, it should have been clear to them that by doing so, they were implicitly assenting to the Company's decision that the performance approach offered through the ECH Program would no longer be an option for builders in the BECo service area.

Turning to the energy and capacity savings estimates developed by the ECH impact evaluation, the record shows that the Company has based its ECH savings estimates on site-specific computer simulations of energy savings and, for the multi-family fossil fuel-heated units, on billing analysis. The record also shows that the Company measured results for the entire participant population in 1991 and 1992. Although the Department generally requires that energy savings be based on after-the-fact measurement techniques, the Department recognizes that the ECH program is not well suited for after-the-fact measurement because there are no pre-treatment energy consumption data against which to compare post-treatment consumption. In

previous Orders, the Department has approved of using engineering estimates in circumstances such as this. The Department finds that the Company has applied reasonable methodologies to evaluate savings from dwellings participating in the ECH Program in 1991 and 1992, and has appropriately reconciled results where more than one method was used to assess program impacts. Further, the Department finds no evidence of bias in the Company's estimates of energy or capacity savings. Finally, the Department finds that the methods employed by the Company to derive savings estimates strike an acceptable balance between the cost of evaluation and the precision of the results. Accordingly, the Department accepts the Company's estimate of 15,830 annualized and 379,920 lifetime KWH and 120 KW-years as the second and final look at 1991 program impacts and 6,914 annualized and 172,966 lifetime KWH and 25 KW-years as the first look estimate of savings for the 1992 implementation of the ECH program.

3. Multifamily Electric Efficiency Program

a. Description

The Company's Multifamily Electric Efficiency Program ("Multifamily Program") was designed to promote energy efficiency services in multifamily buildings with five or more dwelling units (Exh. DPU-29, Executive Summary at 1). The Multifamily Program was initiated in 1991 and is presently in its fourth year of operation (id.). The Multifamily Program provides direct installation of energy saving measures including fixtures and lamps, weatherstripping and storm windows, refrigerator coil brushes and cleanings, water heater and pipe insulation, low flow water devices, ceiling and wall insulation, and thermostat resettings (Exh. DPU-50, at 109). Approximately 1,700 dwelling units in 45 buildings were treated in 1991 (Exh. DPU-29, Executive Summary at 1). In 1992, more than 2,900 dwelling units in 312 buildings were treated

(id.).

The Company performed a comprehensive evaluation of the Multifamily program, including an impact evaluation of program installations during 1991 ("1991 Impact Evaluation"), a preliminary impact evaluation of program installations during 1992, a process evaluation of program implementation effectiveness during 1991 and 1992, and a review of the program database (id. at 1-2). The following section of the Order will focus on the results of the 1991 Impact Evaluation (id.).

The Company stated that the targeted customers and participants were fairly heterogeneous, ranging from small five-unit dwellings to large multi-story buildings, with and without electric space heating (Exh. 29, at 2-1). The buildings could also be differed by being either master-metered or individually-metered (id.).[57]

Based on the 1991 Impact Evaluation, the Company claimed net annual savings estimates for the Multifamily program of 1,264 MWH (id. at 2).[58] The 1991 Impact Evaluation was designed to utilize data from a number of sources including (1) program data for participating customers and the energy efficiency measures installed in their buildings, (2) engineering estimates of expected measure-specific energy savings, and (3) actual billed consumption data before and

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[57] Master-metered buildings are those that have only one electric meter for the building, regardless of the number of living units. An electric company targeting living units for DSM implementation within a master-metered building typically cannot determine the electricity consumption before or after the treatment for any specific unit. Individually-metered buildings have one electric meter for each living unit, thus permitting unit-specific electricity consumption patterns to be determined through customer billing histories.

[58] Projected savings (i.e., based on engineering estimates) for this program during 1991 had been 1,727 MWH (id.).

after installation of the measures, for both participants and for a non-participant comparison group (id.). The Company indicated that a significant amount of manipulation and reorganization of the data was required to develop reliable savings estimates for this program (id. at 2-2). The results of the 1991 Impact Evaluation were developed through a regression analysis to estimate the impact of the program on the participating multifamily households (id.).

In developing the savings estimates for the master-metered buildings, the Company produced two regression equations (id. at 2-16). The first equation included data for all of the master-metered buildings treated through the program (id.). The second equation excluded data for one large building (Building 42) that exhibited an increase in consumption between the pre- and post-installation time periods (id.). The Company stated that it used the second equation to develop final savings estimates because "in the absence of information about the cause of the increase ... it is prudent to avoid 'contaminating' the estimated coefficients" (id.).

The Company also determined that a non-participant comparison group of master-metered buildings showed a reduction in the average electricity consumption for each building of 3.5 percent (id.). The Company concluded that no systematic change in consumption could be identified for the non-participant comparison group after accounting for differences in weather conditions in the before and after periods (id. at 20). However, the Company stated that the change in consumption for the master-metered non-participant comparison group did not correspond to weather conditions over the test period (Exh. DPU-12-3). The Company also noted that the sample size of the master-metered non-participant comparison group was small, and that no information was readily available on the number of units in each building (id.). The Company stated that because the data were limited, it concluded that the reduced energy

consumption for the non-participant comparison group was not statistically significant, and that no adjustment to gross savings was necessary (id.).

In developing the savings estimates for the individually-metered buildings treated through the Multifamily program, the Company determined that the individually-metered non-participant comparison group showed a 1.3 percent increase in consumption (Exh. DPU-21, at 2-16). It also determined that the actual change in seasonal consumption for the individually-metered non-participant comparison group reflected primarily the difference in weather, with the remaining difference being random or unexplained (id. at 2-19). The Company, therefore, included no adjustment to gross savings to determine net savings for individually-metered participants in 1991 (id.).

b. Positions of the Parties

i. The NUPs

The NUPs contend that the evaluation methodology used to estimate savings for the Multifamily program during 1991 was inaccurate because it (1) relied on flawed data sets, (2) arbitrarily excluded buildings with low energy savings, and (3) assumed no change in the non-participant comparison group's consumption (NUP Brief at 29).

First, the NUPs argue that the data sets available to the Company were "sufficiently flawed that none of the results developed in the evaluation analyses are adequate to support program planning or recovery of program costs associated with 1991 lost base revenues and incentives" (id.). The NUPs assert that BECo's witness recognized that the insufficient data was a major problem in the evaluation of the Multifamily program (id., citing Tr. 1, at 32-33).

The NUPs point out that of 1,072 individually-metered units treated in 1991, only 163 of these units could be used by the Company in its analysis (id.). The NUPs also note that of the master-metered multi-family facilities, data were sufficient to include only four out of 16 complexes in the evaluation; these four sites consisted of 18 of the 31 master-metered participant buildings, including 15 buildings in one complex (i.e., Building 43) (id.). The NUPs argue that the results were affected both by the scarcity of participant data and by the fact that the data did not represent the building types and end-uses that were treated by the program during 1991 (id.).

Second, the NUPs contend that an examination of the 1991 Impact Evaluation indicates that data were excluded from the development of the net program savings in a biased manner (id., citing Exh. DPU-21, at 2-19, 2-20). The NUPs state that, in developing the estimates of net program savings for master-metered facilities, the 1991 Impact Evaluation included the results from one master-metered complex that "showed the clearest evidence of savings," but chose not to include in the analysis the one complex of the four with useable data "that exhibited an increase in consumption between the two [i.e., pre- and post-installation] periods"[59] (id. citing Exh. DPU-21, at 2-16, 2-19).

Regarding the individually-metered buildings, the NUPs assert that the basic approach to quantifying the savings from the Multifamily Program was not theoretically sound (id. at 31). The NUPs contend that the analysis undertaken for the 1991 Impact Evaluation did not discriminate

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[59] The NUPs assert that the evaluator chose to accept the observed change in a single master-metered building (i.e., Building 43) without a non-participant correction (id. at 30). The savings associated with the remainder of the master-metered buildings were determined by applying the realization rate associated with the individually-metered buildings.

between savings associated with improvements to the building shell (e.g., ceiling insulation) and savings associated with improvements to individual living units (e.g., window treatments) (id.). The NUPs argue that the distinction is important because savings associated with improvements to individual living units are dependent on the location and physical orientation of the living unit within the building shell (id.).[60]

Third, the NUPs assert that the evaluation methodology used to develop savings estimates for the Multifamily Program inaccurately concluded that there was no change in consumption by the master-metered non-participant comparison group (id. at 29). The NUPs maintain that the 1991 Impact Evaluation did not reflect a 3.5 percent decrease in electricity consumption by this group, which would have indicated that the actual program savings were less than the observed changes in the participants' consumption (id. at 30). The NUPs contest the Company's argument that the changes in electricity consumption among the non-participant comparison group were not statistically significant (NUP Reply Brief at 21). The NUPs assert that the size of the sample makes statistically significant results impossible to attain, and that a "power test" would indicate that statistical significance could not be expected (id.). The NUPs imply that the Company erred in assuming that there were no changes in consumption among the non-participant comparison group because such changes could not be measured in a statistically significant manner (id.).

The NUPs maintain that the 1991 Impact Evaluation was an inadequate basis for estimating net program savings from the Multifamily Program, and that the Company's use of the

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[60] For example, living units that are located in the corner of a building, with more window area, will save more energy from glazing treatment than will living units with less window area located in a central portion of the building (id.).

various results found in the report was arbitrary and biased toward higher savings (NUP Brief at 31). The NUPs contend that, because of these methodological and data problems, the Department should direct BECo to recalculate the savings estimate for the Multifamily program by applying the realization rate from the Public Housing Authority ("PHA") Program (i.e., 57 percent) to the Multifamily Program engineering estimates (id.; NUP Reply Brief at 19-20). The NUPs argue that the realization rate associated with the PHA program is well-supported and is based on building-level analysis that is advocated by the Company (NUP Reply Brief at 20).

ii. The Company

The Company contends that, because of billing data problems, individually-metered units could not be aggregated for analysis as might be preferable (Company Brief at 23). The Company maintains that the goal of the 1991 impact evaluation is to determine realization rates by end-use types across the Multifamily Program on average, not to determine precise realization rates for individual units or buildings (id.). In addition, the Company argues that, in developing the engineering estimates of savings, the location of living units within a building was considered (id.). BECo implies that, because the realization rate developed through the 1991 Impact Evaluation is the ratio of savings estimated from billing data compared to the engineering-estimated savings, the 1991 Impact Evaluation analysis properly incorporates living unit locations and physical orientation (id.). The Company maintains that the NUPs have presented no clear evidence that the sample is unrepresentative or inappropriate for the analysis performed (id.).

In response to the NUPs contention that BECo should have adjusted the gross savings estimates based on the changes in consumption among the non-participant comparison group, the Company contends that the NUPs collaborated in designing many of the Company's programs,

including the Multifamily Program, so that the programs would minimize free riders (id.). The Company also argues that no free-ridership can be substantiated statistically (id.).

The Company maintains that the realization rate from the PHA Program should not be applied to the Multifamily Program savings estimates, as the NUPs advocate (id.). The Company asserts that the PHA Program, which is aimed at publicly administered buildings occupied by low-income tenants, is substantially different from the Multifamily Program, which is targeted to rental and condominium units "where residents have a much greater say in what is done to their living units and probably have a larger initial consumption of electricity with which to work" (id. at 23-24).

c. Analysis and Findings

Four issues arise with respect to the Multifamily Program savings estimates. The first pertains to whether the data were flawed by not properly representing the range of building types and end uses treated by the Multifamily Program. The record indicates that the data were limited to the extent that statistically significant conclusions could not be drawn. The 1991 Impact Evaluation indicates, however, that where significantly different building types and end-uses were treated through the Multifamily Program, an attempt was made to determine the savings from each entity separately. The Department finds that the data did not properly reflect the range of building types treated by the Multifamily Program.

The second issue pertains to whether the 1991 Impact Evaluation developed estimates of net program savings in a biased manner by deleting the data associated with Building 43 from the analysis, and whether the 1991 Impact Evaluation did consider the building shell as a separate entity and take into account the location and physical orientation of the treated living units within

the building. The record provides no information regarding the extent that the results produced by the 1991 Impact Evaluation would have been more sound had they applied data regarding living unit orientation and location. The record indicates that the data associated with Building 43, which contains 140 units, were deleted from the analysis. The 1991 Impact Evaluation indicated that Building 43 showed an increase in consumption between the pre- and post-installation periods of 1.7 percent. The Company stated that it is prudent to delete the data from Building 43, because information regarding the increase in consumption, even after being treated by the Multifamily Program, is absent.

The Department finds that the Company did not provide an adequate basis to delete the data from Building 43, and that, because only data that indicated an increase in consumption were deleted from the analysis, the results of the 1991 Impact Evaluation are biased.

The third issue pertains to the conclusion in the 1991 Impact Evaluation that there was no change in electricity consumption among the non-participant comparison groups in either individually-metered or master-metered buildings. The record indicates that the Company concluded that the change in consumption among the non-participant comparison group was either weather-related or insignificant, and therefore made no adjustment to the gross savings of the participants based on what it considered to be statistically insupportable evidence or flawed and restricted data.

The Department has determined that the restricted quantity and overall quality of the data causes the results of the 1991 Impact Evaluation to be biased. The Department has also determined that we will require a recalculation and reconciliation of the results as explained at the

end of this section. Accordingly, the Department finds that the arguments related to the application of non-participant comparison group data in determining program impacts are moot.

The fourth issue pertains to whether the savings results developed by the Company and presented by BECo for approval are adequate or the realization rate developed through the PHA Program should be applied to the Multifamily Program engineering estimates as requested by the NUPs. The Department has determined that the results of the 1991 Impact Evaluation are inherently biased. The Department agrees with the Company, however, that the PHA Program is fundamentally different from the Multifamily program. Therefore, for the purposes of the instant proceeding, the Department will allow the Company to collect lost base revenues and financial incentive based on the savings estimates developed through the 1991 Impact Evaluation for the Multifamily Program. However, the Department will require the Company to reconcile the results with the realization rates developed for the 1992 Multifamily program implementation, (i.e., to be determined through the 1992 impact evaluation due to be filed on July 29, 1994), assuming that they are found to be statistically significant. Specifically, the Company shall apply measure-specific realization rates developed through the 1992 impact evaluation to the number of measures treated through the 1991 program implementation.

Regarding analysis of the building shell as a separate entity and applying the living unit location and physical orientation within Multifamily buildings to determine net savings, the Department directs the Company to either apply such information to its analysis when recalculating the 1991 Impact Evaluation results, if possible, or to describe in full why such information should not or cannot be applied to the development of net savings estimates.

E. Other Programs

The Department has reviewed the M&E reports of the following programs and found the proposed savings estimates to be sufficiently unbiased and precise: Energy Fitness Program, Efficient Lighting Program,[61] Appliance Labeling Program, Public Housing Authority/Boston Housing Authority Programs, Wattbuster Program, Heat Pump/AC Tune-Up Program, HVAC Rebate Program, and A/C Cycling Program. Therefore, the Department approves the stated savings estimates for these programs for the purposes of calculating LBR and the financial incentive. Approved estimates of savings for each of these programs can be found in Table 4.

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61 The Department notes that in its response to information request DPU-8-15, the Company stated that it discovered an error in its first true-up estimate of savings from the Efficient Lighting Program in 1992. As a result of this error, first true-up "M&E Net" savings should be 8,379,534 KWH for 1992, rather than 9,882,990 as reported in Exh. DPU-51. The Department notes that the Company made this correction in its revised CC calculation filed with the Department on January 28, 1994 (Exhs. DPU-8-15; DPU 51, at 88).

IV. ORDER

Accordingly, after due consideration, it is hereby

ORDERED: That the savings estimates from 1991 DSM installations for which Boston Edison Company has requested approval are approved in part and denied in part, as set forth above; and it is

FURTHER ORDERED: That the savings estimates from 1992 DSM installations for which Boston Edison Company has requested approval are approved in part and denied in part, as set forth above; and it is

FURTHER ORDERED: That the Company shall file a compliance filing in accordance with the directives set forth in this Order. The compliance filing shall contain recalculations of the Company's 1991 and 1992 incentive amounts and lost base revenues where the Department has directed re-calculations in this Order as well as recalculations of the CC rates resulting from these changes, and shall be filed within 7 days after the date of this Order (the Company is invited to comment on the appropriateness of changing CC rates at this time, based on the degree of change to the rates). The Company shall include in its compliance filing tables similar in format to Tables 1 through 3 in this Order, based on its recalculations; and it is

FURTHER ORDERED: That the Company shall comply with all other directives contained herein.

By Order of the Department,

_____
Kenneth Gordon, Chairman

_____
Barbara Kates-Garnick, Commissioner

_____
Mary Clark Webster, Commissioner

Appeal as to matters of law from any final decision, order or ruling of the Commission may be taken to the Supreme Judicial Court by an aggrieved party in interest by the filing of a written petition praying that the Order of the Commission be modified or set aside in whole or in part.

Such petition for appeal shall be filed with the Secretary of the Commission within twenty days after the date of service of the decision, order or ruling of the Commission, or within such further time as the Commission may allow upon request filed prior to the expiration of twenty days after the date of service of said decision, order or ruling. Within ten days after such petition has been filed, the appealing party shall enter the appeal in the Supreme Judicial Court sitting in Suffolk County by filing a copy thereof with the Clerk of said Court. (Sec. 5, Chapter 25, G.L. Ter. Ed., as most recently amended by Chapter 485 of the Acts of 1971).

TABLE 1. SUMMARY OF 1991 AND 1992 DSM ACTIVITIES

	1991	1992
Total DSM Expenditures	$ 38.4 million	$ 53.5 million
Energy Savings, Annual	82 GWH	112 GWH
Fraction of Energy Sales	0.7%	0.9%
Capacity Savings, Annual	46 MW	32 MW
Fraction of Peak Demand	1.7%	1.3%
Lifetime Energy Savings	953 GWH	1,295 GWH
DSM Expense/Total Revenue	2.8%	3.8%
Benefit/Cost Ratio	3.24	1.51
DSM Bonus/Net DSM Value	0.8%	0.6%
DSM Bonus/Value, Non-Settlement	2.4%	3.1%
DSM Cost	4.0 ¢/KWH	4.1 ¢/KWH

Note: "GWH" stands for gigawatthour, which equals one million KWH.

(Exhs. DPU-11-1; BE-1, at 19-A, 19-B).

TABLE 2. 1991 CLAIMED ENERGY SAVINGS AND REALIZATION RATES

	Claimed Annualized MWH	Claimed Realization Rate (%)	Claimed Benefit / Cost Ratio	Accepted by DPU?
ENCORE (Cum. ECMs)	40,379	48	6.00	No
Large C/I Retrofit	14,871	61	1.46	No
Small C/I Retrofit	7,146	75	1.24	Yes
C/I New Construction	2,486	64	2.35	Yes
Equipment Replacement	1,883	N/A	3.45	Yes
Design Plus	933	none	.84	No
Remodeling	96	N/A	.73	Yes
BEEC	115*	80	1.48	Yes
GAP	111*	94	2.39	Yes
Cool Storage	-275*	N/A*	+2.22	Yes
C/I TOTAL	67,745	54	2.41	---
Efficient Lighting	5,568	75	1.28	Yes
Energy Fitness	4,243	37	1.01	Yes
Multi-Family	1,264	69	1.62	No
High Use	1,218	66	2.84	Yes
BHA	909	35	1.01	Yes
PHA	775	72	3.05	Yes
HVAC Rebate	302	44	1.18	Yes
Heat Pump / AC Tune-Up	221	21	.14	Yes
Appliance Labelling	127	91	.49	Yes
Energy Crafted Home	16	N/A	.15	Yes
RESIDENTIAL TOTAL	14,643	50	1.58	---
TOTAL	82,388	53	2.02	---

Costs are the present value of all costs due to 1991 ECM installations, from Exh. BE-1, at 19-A, and so differ from program costs incurred in the current year, used for Table 1.

* Program is designed for capacity savings. Changes in energy use are incidental.

(Exh. BE-1, at 19-A, 60-71, 87-365; BECo DSM Annual Report for 1992).

TABLE 3. 1992 CLAIMED ENERGY SAVINGS AND REALIZATION RATES

	Claimed Annualized MWH	Claimed Realization Rate (%)	Claimed Benefit/ Cost Ratio	Accepted by DPU?
ENCORE (Cumulative ECMs)	56,826	48	1.89	No
Large C/I Retrofit	16,692	61	1.11	No
Small C/I Retrofit	9,609	75	1.65	Yes
C/I New Construction	3,698	82	2.39	Yes
Equipment Replacement	1,249	N/A	1.13	Yes
BEEC	39*	N/A	1.41	Yes
GAP	30*	N/A	.82	Yes
Remodeling	3	N/A	.03	Yes
C/I TOTAL	88,146	54	1.41	---
Efficient Lighting	9,883	75	1.80	Yes
Energy Fitness	5,049	37	1.07	Yes
Multi-Family	2,838	65	1.68	No
High Use	1,886	66	1.89	Yes
BHA	1,649	33	1.32	Yes
PHA	1,323	68	1.08	Yes
Heat Pump / AC Tune-Up	381	20	.15	Yes
HVAC Rebate	122	41	.56	Yes
Energy Crafted Home	7	100	.03	Yes
RESIDENTIAL TOTAL	23,138	54	1.37	---
TOTAL	111,284	54	1.40	---

Costs are the present value of all costs due to 1991 ECM installations, from Exh. BE-1, at 19-A, and so differ from program costs incurred in the current year, used for Table 1.

* Program is designed for capacity savings. Changes in energy use are incidental.

(Exh. BE-1, at 19-A, 75-85, 87-365; BECo DSM Annual Report for 1993).

TABLE 4. 1991 APPROVED ENERGY SAVINGS

	Approved Annualized MWH
ENCORE (Cum. ECMs)	N.A.
Large C/I Retrofit	N.A.
Small C/I Retrofit	7,146
C/I New Construction	2,486
Equipment Replacement	1,883
Design Plus	N.A.
Remodeling	96
BEEC	115*
GAP	111*
Cool Storage	-275*
C/I TOTAL	11,562
Efficient Lighting	5,568
Energy Fitness	4,243
Multi-Family	1,264&
High Use	1,218
BHA	909
PHA	775
HVAC Rebate	302
Heat Pump / AC Tune-Up	221
Appliance Labelling	127
Energy Crafted Home	16
RESIDENTIAL TOTAL	14,643
TOTAL	26,205

N.A. means not applicable, the Department did not approve the Company's savings estimates

* Program is designed for capacity savings. Changes in energy use are incidental.

& The savings estimates for the Multifamily Program are subject to change based on the realization rates developed for the 1992 Multifamily Program implementation.